BULLETIN OF THE IMPERIAL INSTITUTE

A QUARTERLY RECORD OF PROGRESS IN TROPICAL AGRICULTURE AND INDUSTRIES AND THE COMMERCIAL UTILISATION OF THE NATURAL RESOURCES OF THE DOMINIONS, COLONIES AND INDIA

EDITED BY THE DIRECTOR AND PREPARED BY THE SCIENTIFIC AND TECHNICAL STAFF OF THE IMPERIAL INSTITUTE AND BY OTHER CONTRIBUTORS

VOL. XX. 1922.

LONDON
JOHN MURRAY, ALBEMARLE STREET, W.

BULLETIN OF THE IMPERIAL INSTITUTE

VOL. XX. 1922

CONTENTS

PAGE

CONTENTS

CONTENTS

RECENT PROGRESS IN AGRICULTURE AND THE DEVELOPMENT OF NATURAL RESOURCES

CONTENTS

LIST OF ILLUSTRATIONS

THE IMPERIAL INSTITUTE

OF THE

UNITED KINGDOM, THE COLONIES AND INDIA

SUMMARY OF OPERATIONS

An account of the Constitution and Objects of the Imperial Institute with illustrations of its work will be found on pp. ix–xx.

The following are the principal departments of the Institute:

Public Exhibition Galleries.—The collections of raw materials, etc., illustrative of the industrial and commercial resources of the Dominions, Colonies and India, are arranged, together with other exhibits, on a geographical system in the public galleries of the Imperial Institute. The galleries are open free to the public, daily (except on Sundays, Good Friday and Christmas Day), from 10 a.m. to 5 p.m. in summer, and from 10 a.m. to 4 p.m. in winter.

The following British Dominions, Colonies and Dependencies are represented by Collections, which are in charge of Technical Superintendents:

Canada, Newfoundland; Jamaica, Turks and Caicos Islands, British Honduras, British Guiana, Bahamas, Trinidad and Tobago, Barbados, Windward Islands, Leeward Islands, Bermuda; Falkland Islands; New South Wales, Victoria, Queensland, Tasmania, South Australia, Western Australia, Papua, Northern Territory, New Zealand; Fiji, Western Pacific Islands; Union of South Africa, Rhodesia, Nyasaland, St. Helena; Gambia, Sierra

Leone, Gold Coast, Nigeria; Kenya Colony, Zanzibar and Pemba; Uganda; Somaliland; Egypt, Sudan; Malta; Cyprus; Ceylon; Hong Kong; Mauritius; Seychelles; Straits Settlements, the Federated Malay States; and the Indian Empire.

Arrangements are made to conduct schools and educational institutions through the Galleries and to explain the exhibits. A guide-lecturer has been appointed to give demonstrations in the Galleries at stated times.

A Central Stand for the distribution of publications and an Enquiry Office have been opened in the main gallery to provide for the supply of general information and the distribution of literature. Handbooks, pamphlets, circulars, etc., containing information relating to the commerce, agriculture, mining and other industries of the Dominions and Colonies, and also in regard to emigration, are available for free distribution or for sale. Lists of the publications available for distribution or sale are provided, and the principal Colonial and Indian newspapers may be seen on application.

Scientific and Technical Research Department.—The technical laboratories and workrooms of this Department were established in order to provide for the investigation of new or little-known raw materials from the Dominions, Colonies and India, and of known products from new sources, with a view to their utilisation in commerce. Materials investigated by the Department are in promising cases submitted to further technical trials by manufacturers and other experts, and finally are commercially valued.

The work of this Department is chiefly initiated by the Home, Dominion and Colonial Governments and the Government of India. Arrangements have also been made by the Department of Overseas Trade whereby British representatives abroad may transmit to the Institute, for investigation, such raw materials of the countries to which they are appointed as are likely to be of interest to British manufacturers and merchants.

Special analyses and investigations are undertaken

for firms or private persons in any part of the Empire on payment of appropriate charges. Application for such investigations should be made, in writing, to the Director.

A Reference Sample Room is maintained in this Department, in which are arranged samples of the principal raw materials which have been investigated and valued commercially during recent years, and as to which full information can be supplied. A reference collection of standard raw materials of commerce is also available for inspection.

The Department works in co-operation with the Agricultural, Mines and other Technical Departments in the Dominions, Colonies and India, whose operations it supplements by undertaking investigations and enquiries of a special scientific or technical character connected with agricultural or mineral development, as well as enquiries relating to the composition and commercial valuation of products (animal, vegetable or mineral) which can be more efficiently conducted at home in consultation with manufacturers and merchants, with a view to the local utilisation of these products or to their export.

Mineral Surveys are conducted in countries of which the mineral resources are little known. All minerals found that are likely to be of commercial importance are forwarded to the Imperial Institute, where they are examined and their composition and commercial value ascertained. Reports on the results of mineral exploration in Ceylon, Northern Nigeria, Southern Nigeria, and Nyasaland have been published (see pp. vii–viii). The work of the Imperial Institute on minerals is carried on with the advice of the Committee on Mineral Resources.

Technical Information Bureau.—This is a branch of the Scientific and Technical Research Department which has been formed to deal with the large and increasing number of enquiries received by the Imperial Institute from manufacturers, merchants and others, throughout the Empire. The Bureau has devoted special attention to questions relating to the raw materials required for the

industries of the Empire. It has supplied technical information to enquirers, and has issued circulars and pamphlets dealing with various problems in connection with the supply and disposal of raw materials of all kinds.

Indian Trade Enquiry.—In 1916, the Secretary of State for India requested the Committee for India of the Institute to enquire into and report on the possibilities of extending the industrial and commercial utilisation of Indian raw materials in this country and elsewhere in the Empire. Special Committees were appointed to deal with the more important groups of Indian materials, to consider the results of investigations and enquiries already conducted at the Imperial Institute, and to obtain the views of leading merchants, manufacturers, and other users of the raw materials of India. A number of reports have been furnished to the India Office, and are now in course of publication (see p. vii).

Tropical African Services Course.—Courses of instruction in certain specified subjects are given at the Imperial Institute to candidates selected by the Colonial Office for administrative appointments in East and West Africa. Instruction in these Courses in the subject of Tropical Economic Products is given by a member of the Staff of the Imperial Institute.

Library, Reading-Rooms and Map-Room.—The library and reading-rooms of the Imperial Institute contain a large collection of works of reference, and are regularly supplied with the more important official publications, and with many of the principal newspapers and periodicals of the United Kingdom, the Dominions, the Colonies, India and Foreign Countries. Special attention is given to publications relating to tropical agriculture and forestry, mineral resources, and the production and utilisation of raw materials.

The map-room, which adjoins the reading-rooms, is provided with a large collection of recent maps of the

Dominions, the Colonies and India, which can be seen on application.

Conference Rooms.—These rooms, specially decorated and furnished, are reserved on the principal floor for use by representatives of the Dominions and Colonies and for meetings and receptions.

The Cowasjee Jehangier Hall.—The Bhownaggree corridor and rooms in connection with the Cowasjee Jehangier Hall are in the occupation of the Indian Section of the Imperial Institute, whilst the Hall is available for lectures, meetings, etc.

Publications

Bulletin of the Imperial Institute.—The BULLETIN is published quarterly by Mr. John Murray, 50A, Albemarle Street, London, and may be purchased through any bookseller. It contains records of the principal investigations carried out at the Imperial Institute, and special articles chiefly relating to the industrial utilisation of raw materials and progress in tropical agriculture.

Handbooks to the Commercial Resources of the Tropics.—The Secretary of State for the Colonies has authorised the preparation of a series of handbooks dealing with the Commercial Resources of the Tropics, with special reference to West Africa. The handbooks are edited by the Director of the Imperial Institute and published by Mr. John Murray. The volumes already issued, some of which are now in their second edition, are: *The Agricultural and Forest Products of British West Africa*, by Gerald C. Dudgeon, C.B.E., lately Consulting Agriculturist and Director-General of Agriculture in Egypt, and previously Inspector of Agriculture for British West Africa; *Cocoa: Its Cultivation and Preparation*, by W. H. Johnson, F.L.S., Director of Agriculture in Southern Nigeria; *Rubber: Its Sources, Cultivation and Preparation*, by Harold Brown, Technical Superintendent, Scientific and Technical Department, Imperial Institute; and *Cotton and other*

Vegetable Fibres: their Production and Utilisation, by Ernest Goulding, D.Sc., F.I.C., Scientific and Technical Department, Imperial Institute.

Monographs on Industrial Resources.—The Imperial Institute has devoted special attention to the question of securing the utilisation in the United Kingdom of the large quantities of materials produced within the Empire which before the war were exported chiefly to foreign countries. In order to call attention to the subject of oil seeds, a monograph, entitled *Oil Seeds and Feeding Cakes*, has been issued. This book, which is published by Mr. John Murray, deals with the production and utilisation of copra, palm kernels, ground nuts, sesame seed and mowra seed, and the oils and feeding cakes obtained from them.

The Mineral Resources Committee of the Imperial Institute have arranged for the publication of a series of monographs on mineral resources with special reference to those of the British Empire. These are intended to draw attention to the sources of supply of important minerals within the Empire as compared with those which occur in foreign countries, and to give information respecting commercial uses and value of these minerals. The following monographs have been published, and may be obtained from the Imperial Institute: Zinc Ores, Manganese Ores, Tin Ores, Tungsten Ores, Chromium Ore, Platinum Metals, Lead Ores, Silver Ores, Coal, Petroleum, Oil Shales, and Potash.

A new and enlarged edition of the Map and Diagrams of the Chief Metal Resources of the Empire, prepared at the Imperial Institute with the advice of the Imperial Institute Committee on Mineral Resources, is now issued. The chief British countries of occurrence and production of the principal minerals are shown on the map. The diagrams give the outputs of these countries in relation to the production of other countries of the world. The metals dealt with are: gold, silver, platinum, copper, tin, lead, zinc, antimony, aluminium, bismuth, iron, manganese, chromium, nickel, tungsten, molybdenum, vanadium, and mercury.

The map and diagrams can be obtained unmounted or mounted on rollers as a wall map. The publication is obtainable from the Imperial Institute.

Reports of the Indian Trade Enquiry.—The Reports of the Special Committees appointed in connection with the Indian Trade Enquiry (see p. iv) are now in course of publication, the first six volumes of the series being *Hides and Skins; Oil Seeds; Rice; Timbers and Paper Materials; Jute and Silk;* and *Lac, Turpentine and Rosin.* The reports contain important information and recommendations regarding the extension of the industrial and commercial utilisation of Indian raw materials, as well as statements on the general position of each commodity prepared at the Imperial Institute for the use of the Committees. The volumes are published by Mr. John Murray.

Selected Reports from the Scientific and Technical Department.—These reports, which are issued in the Miscellaneous Series of Colonial Reports, contain a summary of the results of technical and commercial investigation of certain raw materials conducted in the Scientific and Technical Research Department of the Imperial Institute since 1903. Five of these Selected Reports have been published: Part I. "Fibres" (1909); Part II. "Gums and Resins" (1909); Part III. "Foodstuffs" (1910); Part IV. "Rubber and Gutta Percha" (1912); Part V. "Oilseeds, Oils, Fats and Waxes" (1914). A collection of earlier reports was printed in a volume of "Technical Reports and Scientific Papers" issued by the Imperial Institute in 1903.

Mineral Survey Reports.—The following reports on the results of mineral surveys conducted in connection with the Scientific and Technical Department of the Imperial Institute have been published in the Miscellaneous Series of Colonial Reports: *Ceylon* (five reports), 1903–4, 1904–5, 1905–6, 1906–8, 1909–10; *Northern Nigeria* (five reports), 1904–5 (two), 1905–6, 1906–7, 1907–9; *Southern Nigeria* (nine reports), 1903–4 and 1904–5, 1905–6, 1906–7, 1907–8,

1908–9, 1910, 1911, 1912, 1913; *Nyasaland Protectorate* (three reports), 1906–7, 1907–8, 1908–9.

Organisations with Headquarters at the Institute

International Association for Tropical Agriculture, British Section.—The object of this Association, the Central Bureau of which is in Paris, is to promote the scientific and practical study of all questions connected with tropical agriculture, including the development and utilisation of natural resources, and to arrange for International Congresses. The British Section has its headquarters at the Imperial Institute. Members of the British Section receive the Bulletin of the Imperial Institute and are permitted to use the library and reading-rooms of the Imperial Institute.

Overseas Nursing Association.—An office on the mezzanine floor has been allotted to this Association, the principal object of which is the selection of trained hospital and private nurses for service in the Crown Colonies and Dependencies.

African Society.—This Society has been provided temporarily with an office at the Imperial Institute.

Empire Forestry Association.—This Association, which is working in conjunction with the Imperial Institute Advisory Committee on Timbers, has been provisionally provided with office accommodation at the Imperial Institute.

IMPERIAL INSTITUTE

I. CONSTITUTION AND OBJECTS

The Imperial Institute, founded on the initiative of King Edward VII. as the Empire Memorial of the Jubilee of Queen Victoria, was a united effort of the people of Great Britain and the British Commonwealth and Colonies overseas. From the contributions received from all parts of the Empire the building at South Kensington was erected and a capital sum invested as an Endowment Fund.

The problem remained to provide adequately for the current expenditure needed to make the Institute a centre and clearing house for information and investigation for the commercial development of the natural resources of the Empire and the promotion of inter-Imperial commerce and industry and of other incidental or supplementary objects.

The first Corporation of the Imperial Institute, having been provided with a Royal Charter, commenced various activities in order to carry out these purposes. The foundations of the Exhibition Galleries, of an Intelligence Department and a Journal were laid, and subsequently with the aid of additional contributions from public bodies in this country, including certain of the City Companies, an Investigation Department was initiated and research laboratories provided. The principal energies of the Corporation were, however, devoted to enlisting the financial support and interest of the general public in making the Institute a place of popular resort, and with this intention there was founded in connection with it what was to all intents and purposes a Club in which all the usual social facilities were provided in the form of

luncheon and dining rooms, concerts and periodical popular exhibitions at a small annual subscription from the Members.

The income thus provided proved, however, to be insufficient to maintain these facilities and also to enable the principal purpose for which the Institute was founded to be developed.

The Corporation eventually decided to abandon the social side of the Institute, and to transfer to H.M. Government the building, the invested funds and the existing Departments of the Institute's work to be developed as a Government Institution for the chief purpose of promoting the utilisation of the resources of the Empire. Accordingly, in 1900 the building became the property of H.M. Government, by whom the western portion and galleries were leased to the Corporation, the greater part of the eastern and central portions being assigned, subject to rights of usage, for occupation by the University of London.

Until the end of 1902 the Imperial Institute was managed by a Governing Body, of which H.R.H. the Prince of Wales (afterwards King Edward VII.) was the first President, and an Executive Council, including representatives of the Indian Empire and of all the British Colonies and Dependencies. In July 1902 an Act of Parliament was passed transferring the management of the Imperial Institute to the Board of Trade, assisted by an Advisory Committee including representatives of the Dominions, Colonies and India, as well as of the Colonial and India Offices, the Board of Agriculture and the Board of Trade.

In April 1916 the Imperial Institute (Management) Act was passed transferring the property and management of the Imperial Institute to the Secretary of State for the Colonies. The Act provides for the appointment of an Executive Council consisting of twenty-five members, nominated by the Board of Trade, the Secretary of State for India (two each), the Ministry of Agriculture and Fisheries, the Government of India, the Governments of the several Dominions (one each), and the Secretary

of State for the Colonies (fourteen). A list of the present members of the Council is given on pp. xxi and xxii and also of the various Committees which have been appointed (pp. xxii-xxvii).

Since 1903, the operations of the Institute have been maintained and extended on the lines indicated above, and all its available funds have been devoted to the principal purpose for which the Institute was founded.

The principal work of the Imperial Institute, therefore, is now concerned with the development of the commercial and industrial use of the raw materials of the Empire, both at home and in the other parts of the Empire, which the Council desire to promote by systematic methods with competent advice and assistance.

The work is chiefly carried on in the three principal departments of the Institute relating to Investigation, Intelligence and Exhibition, the staff of which includes officers with special qualifications in the sciences of chemistry, botany, geology and mineralogy, and in certain branches of technology, in their relation to commerce and to the industrial utilisation of raw materials. Associated with this work are a number of Advisory Committees. Each of the Dominions and India has a Special Committee, including members with knowledge of the trade and industries of these countries. These Committees review the work of the Institute for the countries concerned, and make suggestions regarding it. In addition there are several Technical Committees, including representatives of the trades or industries concerned with the more important groups of raw materials, such as timber, rubber, silk, tanning materials and minerals, which deal with the results of the work of the Institute on these materials and suggest further subjects for investigation. These Committees also advise as to the steps required to make known the value of a given material to particular trades or industries.

Besides these special Technical Committees, there is

also a general Raw Materials Committee, nominated by the Association of British Chambers of Commerce, which includes members of the principal Chambers of Commerce. This Committee is chiefly concerned in making known to the commercial community, through the Chambers of Commerce, results of investigations conducted at the Imperial Institute which, in the opinion of the Committee, are of importance to trade and commerce. This Committee is also the means of suggesting new subjects for investigation.

II. SCOPE AND ORGANISATION OF WORK

Investigations.—The Scientific and Technical Department is equipped with extensive laboratories and workshops for the investigation of raw materials, including problems relating to the uses for new materials or those concerned with extended uses of known materials. This Department has the advice of the Technical Committees already referred to, and is also in communication with merchants and manufacturers through whom large scale trials are made of materials which investigations and preliminary trials at the Imperial Institute have indicated are of probable value. The Department is also in communication with scientific and technical institutions at home and elsewhere in the Empire who are in a position to furnish special information or to undertake special technical and scientific research.

The laboratory investigations, etc., conducted at the Imperial Institute are principally concerned with discovering the appropriate use for a particular material, and are usually limited to this purpose. When this purpose has been secured any further research is for the industry concerned, or for a special technical or scientific research institution, or individual worker. It is obviously impossible for the Institute to carry its operations in all subjects beyond the point indicated, but in addition to

fulfilling its principal object, it constitutes an important centre and clearing house for the distribution to other bodies of problems and materials which present possibilities for investigation from other points of view.

It should also be observed that this Department does not desire to conduct investigations which can be as well or better conducted by institutions in the countries of origin overseas. It is ready to co-operate in work conducted in institutions in the Dominions, and to undertake such investigations as can with advantage be conducted at the Imperial Institute, or those in which technical trials and special information are required which can best be afforded in communication with manufacturers and others in this country.

This Department is responsible each year for some hundreds of reports relating chiefly to the utilisation of mineral and vegetable raw materials which are made to the Governments of the countries concerned, or to the firms and individuals here and overseas which have requested them.

Intelligence.—A branch of the Scientific and Technical Department has been formed for the double purpose of collecting and issuing information respecting the origin and uses of raw materials. Its business is to collect and critically review all published information, including that issued in foreign countries, and this information is utilised in the current work of the Scientific and Technical Department and also in answering the numerous enquiries which are addressed to the Institute from all parts of the world. This branch, which includes an extensive Library, also assists in the collection of information which is printed in the quarterly Bulletin of the Imperial Institute, and in the preparation of the other publications issued by the Institute (see pp. v–viii).

Exhibitions.—The Exhibition Galleries of the Imperial Institute, which constitute a permanent exhibition of the chief resources of the countries composing the British

Empire, have been recently reorganised, enlarged and extended. The arrangement of the Galleries is geographical, each country having its own sectional space. Not only are the chief raw materials and industries of each country displayed and explained by descriptive labels, but the Court of each country contains maps, diagrams of production and trade, and photographs of leading cities, towns and scenes of industry and other objects of special interest. Their Majesties the King and Queen have taken great interest in these Collections and have presented many exhibits which are shown in the respective Courts. H.R.H. the Prince of Wales has lent for exhibition the Presents and Addresses received during his visits to Canada and Australasia.

This exhibition of the chief resources of each country of the Empire is open to the public without payment, and its value is enhanced by the attachment of a technical staff competent to supply full information regarding these resources, including that relating to their industrial uses.

These unique Collections are of importance, not only in connection with the work of investigation and intelligence carried out at the Imperial Institute and for commercial purposes, among which is the supply of samples required for trade or industrial trial, but they are also of special importance to the teaching of the commercial geography of the Empire in the public schools and other institutions in this country. In this connection and for the purpose of providing the general information required by the public, a Guide Lecturer has been appointed who at stated times explains the nature and significance of the exhibits of each country to parties from schools or of the general public.

With the co-operation of the Dominions and the other countries of the Empire, it is hoped to maintain these Collections to serve this important public educational purpose, in addition to being a means of attracting attention to the resources of the Empire and the opportunities they present for development. Among other activities

which are contemplated is the arrangement of local exhibitions throughout the Provinces. This plan has been suggested by the Raw Materials Committee in order to draw further attention to the commercial and industrial possibilities of new raw materials from within the Empire which have been under investigation at the Institute.

III. ILLUSTRATIONS OF WORK ON THE UTILISATION OF RAW MATERIALS

As already indicated, the main object of the operations of the Imperial Institute is not only to develop the resources of the Dominions and Colonies but also to promote inter-Imperial trade between the constituent parts of the Empire. There are raw materials in the Dominions and Colonies which are of importance not only to the United Kingdom but to other British countries, and there are also materials which are important to the growing industrial development of the Dominions which are to be obtained not only in the United Kingdom but elsewhere within the Empire. It is because the Imperial Institute is in close touch with producers and the conditions of production in all parts of the Empire that it is in a unique position to promote this co-operation in the usage of Empire materials for the mutual benefit of the countries concerned.

Apart from its work in collecting and disseminating information on these subjects, and over and above the work it is doing to extend the usage within the Empire of materials already known, special attention is devoted to finding employment for new or little-known raw materials, either within the country of production or by manufacturers elsewhere in the Empire. A few illustrations of some of the results of the Institute's operations in the latter direction are appended.

Drugs.—In connection with the manufacture of drugs and chemicals, the Institute has demonstrated the value

of Indian opium for medicinal purposes and for the manufacture of morphia and other alkaloids. As a result, Indian opium is now taking the place of the opium obtained from Persia and Turkey, which a few years ago was almost exclusively used, whilst Indian opium was not employed. In the four years 1916–19, the average annual value of the Indian opium imported into this country for manufacturing purposes was nearly £400,000.

The work of the Institute has also led to the seed of the Indian ajowan plant being utilised in England and India for the manufacture of the drug known as thymol, nearly all of which was formerly manufactured in Germany. Again, for the manufacture of atropine and similar alkaloids used in medicine, the Institute has demonstrated the value of the wild henbane of Egypt, which formerly found no use, but is now an article of export from Egypt and is employed in the manufacture of these substances.

Oil Seeds.—Investigations conducted at the Imperial Institute showed that Para rubber seeds, which are produced in large quantities on the plantations in the East, contain a valuable drying oil, and that the residual meal or cake left after the removal of the oil is of high nutritive value and suitable for use as a feeding-stuff for animals. It has been definitely established that the oil would have a ready sale as a substitute for linseed oil, and that the residual cake is comparable in nutritive value and digestibility with linseed cake and decorticated cotton-seed cake. As a result of these investigations of the Imperial Institute, the possibility of exploiting the seeds has received considerable attention from planters, and commercial shipments of rubber-seed oil have now been made to the United Kingdom.

In view of the great shortage of drying oils employed in the manufacture of paints and varnishes, steps have been taken by the Imperial Institute to obtain from British sources supplies of Perilla oil and Tung oil (Chinese

wood oil) which have hitherto been prepared from seed grown in China and Japan. Supplies of seed have been distributed to suitable British possessions, and cultivation experiments are now in progress. From the results already obtained it appears that it will be possible to cultivate both seeds on a commercial scale in one or more of the countries selected.

Minerals.—The Institute has been instrumental in finding uses for a large number of minerals from various parts of the Empire. The composition of these has been determined, their value ascertained, and users here and elsewhere put into communication with the producers overseas. The work of the Institute led to the discovery of thorium minerals in Ceylon and their value for the manufacture of gas mantles ; and, through its operations, not only has the working of the minerals in Ceylon been developed, but an export trade and the use by manufacturers of these materials have been brought about, and there is now a regular export which takes the place of similar materials formerly obtained under German auspices from Brazil.

The work of the Mineral Survey of Southern Nigeria, which was conducted in co-operation with the Imperial Institute, led to the discovery of an important coalfield, estimated to be at least 1,800 square miles in extent, in the neighbourhood of Udi. An extensive series of samples of the coal was examined at the Imperial Institute and the results showed that the coal was of good quality and suitable for general use, including steam raising. The coal has now been worked for some time and a large quantity has already been produced. There seems no doubt that this coalfield will ultimately render West Africa independent of imported coal.

The work of the Institute has also been of material assistance in the development of the tin-mining industry in Nigeria.

Prior to the war British steel-makers had relied largely

on Germany, France and the United States for supplies of the alloys of tungsten, molybdenum, titanium, tantalum, etc., which are used in the manufacture of high-speed and other special steels, although nearly all the ores from which these alloys are made are more or less monopolies of the British Empire so far as production is concerned. During the war the Institute was instrumental in placing alloy makers in this country in touch with producers of these ores, and took action to increase the supply of other ores of which there was a great shortage in the early part of the war. The Institute was also able to render useful assistance in directing attention to available supplies of various other minerals for which a considerably increased demand arose under war conditions.

Paper.—For the manufacture of paper, the Institute has shown that, besides wood, there are numerous materials in different parts of the Empire which could be successfully employed to meet the local demand for paper, and also to initiate where practicable an export trade in the pulp. Among these materials may be mentioned the spent wattle bark of South Africa, which remains after a tanning extract has been prepared from this bark, and hitherto has been a waste product. The value of this material for paper-making has been demonstrated, as well as that of other South African materials which can be employed for the purpose. Works are now being erected in South Africa, with the advice of the Institute, for the manufacture of paper and cardboard, for which there is a great demand in South Africa met by imported material.

Similarly, through the work of the Institute, the papyrus of Zululand is to be utilised in South Africa for the manufacture of paper pulp. The Institute has also proved the value for the manufacture of paper pulp of the enormous areas of bamboo and elephant grass which exist in East Africa, and the commercial exploitation of these materials is now under consideration.

The Institute suggested that steps should be taken to utilise the large quantities of waste wood produced annually in New Zealand, and subsequently showed by technical trials that certain of the woods are eminently suitable for the preparation of paper pulp.

Investigations conducted at the Imperial Institute have shown that the waste cotton stalks, left after the crop has been harvested, are a promising paper-making material, and practical trials have been suggested in paper mills in India.

Tanning Materials.—In connection with tanning materials, the Institute has been instrumental in promoting the manufacture in South Africa of the extract of wattle bark which was formerly made in Germany, and has also demonstrated the value of the Sant pods of the Sudan, and has initiated the export of this material to this country for use by tanners, who have been satisfied as to its value for the manufacture of leather.

Timbers.—In connection with the timber trade, the Institute has been the means of showing how special requirements of manufacturers can be met by the use of little-known timbers from within the Empire, and, in this connection, has recently found outlets for woods from India, New Zealand, South Africa and elsewhere. During the war when supplies of boxwood from Turkey could no longer be obtained for the manufacture of engraving blocks, bobbins, etc., the Institute drew attention to the boxwood of South Africa and supplied, for trial, specimens of the wood from the Collections. The results of these trials being satisfactory, prospective users were put into communication with producers in South Africa, from whom supplies were obtained and an export trade to this country initiated.

The Timbers Committee of the Imperial Institute has recently considered how the use of Canadian timbers in the United Kingdom could be extended. In this connection the Committee took action to secure the inclusion

of certain British Columbian timbers in the official Timber Specifications for Government buildings in the United Kingdom. In consultation with the Office of Works it was arranged that mechanical tests and practical working trials, including extended joinery tests, should be carried out with selected timbers of British Columbia, and it was agreed that if the results were satisfactory, these timbers should be included in the official specifications. The results of the mechanical tests and practical trials showed that the British Columbian timbers are at least equal to similar European timbers which are widely used in the United Kingdom.

In view of these satisfactory results the Office of Works has decided that Douglas Fir, Tideland Spruce and Western Hemlock from British Columbia shall be included in the official timber specifications of that Department as alternatives to established European woods.

Action has also been taken regarding certain woods of Eastern Canada which the Committee recommends should be used more widely in this country. H.M. Office of Works is now prepared to accept timbers from Eastern Canada, provided that they conform to the official standards of quality.

The operations of the Imperial Institute principally depend for their success on the work of a skilled staff with extensive knowledge of the scientific, technical and commercial aspects of the production and usage of raw materials.

The experimental " research " work conducted at the Institute is generally restricted to such preliminary investigation as is needed to determine the character of a material and its possible industrial applications. The remainder of the work is conducted in association with the manufacturers and users concerned, and with any scientific or technical institution which is capable of rendering further assistance.

TRUSTEES

Executive Council

(Appointed in 1919 under the provisions of the Imperial Institute (Management) Act, 1916)

	Appointed by
P. W. L. Ashley, Esq., C.B., Board of Trade. R. W. Matthew, Esq., Department of Overseas Trade.	The Board of Trade.
Sir J. P. Hewett, G.C.S.I., K.B.E., C.I.E., lately Lieut.-Governor, United Provinces, India. Sir L. J. Kershaw, K.C.S.I., C.I.E., India Office.	The Secretary of State for India.
Sir Daniel Hall, K.C.B., F.R.S., Ministry of Agriculture.	The Ministry of Agriculture and Fisheries.
Sir R. W. Carlyle, K.C.S.I., C.I.E., lately Member, Governor-General's Council, India.	The Government of India.
The High Commissioner for Canada.	The Government of the Dominion of Canada.
The High Commissioner for Australia.	The Government of the Commonwealth of Australia.
The High Commissioner for South Africa.	The Government of the Union of South Africa.
The High Commissioner for New Zealand.	The Government of the Dominion of New Zealand.
The High Commissioner for Newfoundland.	The Government of Newfoundland.

Secretary to the Council, H. M. Lidderdale, Esq., Imperial Institute.

Director of the Imperial Institute

Wyndham R. Dunstan, Esq., C.M.G., M.A., LL.D., F.R.S.

Finance and General Purposes Committee

The Right Hon. Lord Islington, G.C.M.G., D.S.O. (*Chairman*).
The Right Hon. Viscount Burnham, C.H.
Sir R. W. Carlyle, K.C.S.I., C.I.E. (*Vice-Chairman*).
A. Fiddian, Esq.
Sir Algernon Firth, Bart.
Sir Gilbert Grindle, K.C.M.G., C.B.
Sir J. P. Hewett, G.C.S.I., K.B.E., C.I.E.
D. O. Malcolm, Esq.
Sir William Taylor, K.C.M.G.

Committees for the Dominions

Committee for Canada

The High Commissioner for Canada (*Chairman*).
J. G. Colmer, Esq., C.M.G., formerly Secretary to the High Commissioner's Office.
Sir R. M. Kindersley, G.B.E., Governor, Hudson's Bay Company.
J. H. Plummer, Esq., Chairman, Dominion Steel Corporation.
Sir Keith Price, Messrs. Price & Pierce.

Committee for Australia

The High Commissioner for Australia (*Chairman*).
Sir Gordon Campbell, K.B.E., Messrs. W. Weddel & Co., Ltd.
Captain Sir Robert Muirhead Collins, R.N., C.M.G., lately Official Secretary to the Commonwealth, in London.
E. V. Reid, Esq., Messrs. Dalgety & Co.

Committee for New Zealand

The High Commissioner for New Zealand (*Chairman*).
W. Acton Adams, Esq., J.P., F.R.G.S.
James Coates, Esq.
G. F. Gee, Esq.
R. D. Douglas McLean, Esq.
Alexander Michie, Esq.
Sir James Mills, K.C.M.G.
W. H. Montgomery, Esq., C.B.E.
R. H. Nolan, Esq., C.B.E.

Committee for the Union of South Africa and Rhodesia

The High Commissioner for the Union of South Africa (*Chairman*).
A. Canham, Esq., Trade Commissioner for the Union of South Africa.
D. O. Malcolm, Esq., British South Africa Company.
C. W. S. Maude, Esq., British South Africa Company.
William Mosenthal, Esq., Messrs. Mosenthal, Sons & Co.
William S. Soper, Esq., M.A., Messrs. Davis & Soper, Ltd.

Committee for India

Sir C. C. McLeod, Chairman, East India Section, London Chamber of Commerce (*Chairman*).

Sir Harvey Adamson, K.C.S.I., lately Lieut.-Governor, Burma (*Vice-Chairman*).

A. Yusuf Ali, Esq., C.B.E., late Indian Civil Service.

Sir Charles H. Armstrong, Messrs. Lyon, Lord & Co.

The Right Hon. Lord Cable, Messrs. Bird & Co.

Sir R. W. Carlyle, K.C.S.I., C.I.E., lately Member of Governor-General's Council, India.

The Right Hon. Lord Carmichael, G.C.S.I., G.C.I.E., K.C.M.G., lately Governor of Bengal.

D. T. Chadwick, Esq., C.I.E., Indian Trade Commissioner.

Sir J. P. Hewett, G.C.S.I., K.B.E., C.I.E., lately Lieut.-Governor, United Provinces, India.

Sir L. J. Kershaw, K.C.S.I., C.I.E., India Office.

Sir George Sutherland.

Technical Committees

Raw Materials Committee

(Nominated by the Association of British Chambers of Commerce)

Sir Algernon Firth, Bart. (*Chairman*), lately President, Association of British Chambers of Commerce.

F. W. Astbury, Esq., M.P., Dr. Alfred Rée, } Manchester Chamber of Commerce.

Sir Cecil W. N. Graham, W. F. Russell, Esq., } Glasgow Chamber of Commerce.

G. A. Moore, Esq., J. Pickering-Jones, Esq., } Liverpool Chamber of Commerce.

A. C. Powell, Esq., Bristol Chamber of Commerce.

A. M. Samuel, Esq., M.P., Norwich Chamber of Commerce.

H. H. Sissons, Esq., Hull Chamber of Commerce.

Dr. J. E. Stead, F.R.S., Middlesbrough Chamber of Commerce.

H. L. Symonds, Esq., London Chamber of Commerce.

Alexander Johnston, Esq., Federation of British Industries

R. B. Dunwoody, Esq., O.B.E., Association of British Chambers of Commerce. H. Brown, Esq., Imperial Institute. } *Secretaries.*

Mineral Resources Committee

The Right Hon. VISCOUNT HARCOURT, D.C.L. (*Chairman*).

Admiral Sir EDMOND SLADE, K.C.I.E., K.C.V.O. (Nominated by the Admiralty) (*Vice-Chairman*).

EDMUND G. DAVIS, Esq.

Prof. C. H. DESCH, D.Sc., Professor of Metallurgy, University of Sheffield.

WYNDHAM R. DUNSTAN, Esq., C.M.G., LL.D., F.R.S.

Captain A. L. ELSWORTHY, Military Intelligence Department, War Office (Nominated by the War Office).

Prof. J. W. GREGORY, D.Sc., F.R.S., Professor of Geology, University of Glasgow; formerly Director of Geological Survey, Victoria, Australia.

Sir ROBERT HADFIELD, Bart., F.R.S., formerly President, Iron and Steel Institute.

A. HUTCHINSON, Esq., O.B.E., M.A., Ph.D., F.R.S., Department of Mineralogy, University of Cambridge.

W. W. MOYERS, Esq., Messrs. H. A. Watson & Co., Ltd.

J. F. RONCA, Esq., M.B.E., A.R.C.Sc., A.I.C., Board of Trade (Nominated by the Board of Trade).

R. ALLEN, Esq., M.A., B.Sc., Imperial Institute (*Secretary*).

Ceylon Rubber Research Committee

WYNDHAM R. DUNSTAN, Esq., C.M.G., LL.D., F.R.S. (*Chairman*).

Sir STANLEY BOIS. G. H. GOLLEDGE, Esq. Sir EDWARD ROSLING.	(Representing Ceylon Planting Interests).
F. W. BARKER, Esq. H. ERIC MILLER, Esq. HERBERT WRIGHT, Esq.	(Nominated by the Rubber Growers Association).
PERCY ROSLING, Esq., Henley's Telegraph Works Company. D. F. TWISS, Esq., D.Sc., F.I.C., The Dunlop Rubber Company. W. A. WILLIAMS, Esq., The North British Rubber Company.	(Representing Rubber Manufacturing Companies).
ALEXANDER JOHNSTON, Esq.	(Nominated by the Research Association of British Rubber and Tyre Manufacturers).

Prof. J. B. FARMER, M.A., D.Sc., F.R.S.

H. BROWN, Esq. (*Secretary*).

Silk Production Committee

Sir Frank Warner,[1] K.B.E., Messrs. Warner & Sons, Vice-President, Silk Association (*Chairman*).

Sir Henry Birchenough, Bart., K.C.M.G.

Norton Breton,[1] Esq., Messrs. Henckell, Du Buisson & Co.

Wyndham R. Dunstan, Esq., C.M.G., LL.D., F.R.S.

Frank J. Farrell, Esq., M.Sc., Messrs. Grout & Co., Ltd., Vice-President, Silk Association.

William Frost,[1] Esq., J.P., Messrs. W. Frost & Sons, Ltd.

Prof. H. Maxwell Lefroy, M.A., Imperial College of Science and Technology.

J. Sugden Smith,[1] Esq., Messrs. John Hind & Co., Ltd., Vice-President, Silk Association.

Richard Snow,[1] Esq., Messrs. H. Windley & Co., Vice-President, Silk Association.

A. John Solly,[1] Esq., J.P., Messrs. Reade & Co., Ltd., Vice-President, Silk Association.

H. Solman, Esq., Messrs. John Heathcoat & Co.

William Stokes, Esq.

William Watson,[1] Esq., Messrs. Lister & Co., Ltd., Vice-President, Silk Association.

Dr. S. E. Chandler (*Secretary*).

[1] *Nominated by the Silk Association of Great Britain and Ireland.*

Timbers Committee

H. D. SEARLES-WOOD, Esq., F.R.I.B.A. (Nominated by the Royal Institute of British Architects and by the Empire Forestry Association) (*Chairman*).

W. E. VERNON CROMPTON, Esq., F.R.I.B.A.
DIGBY L. SOLOMON, Esq., B.Sc., A.R.I.B.A.
(Nominated by the Royal Institute of British Architects).

C. J. MORGAN, Esq., Messrs. Foy, Morgan & Co. (Nominated by the Timber Trade Federation of the United Kingdom).

JAMES RICHARDSON, Esq. (Nominated by the Timber Trade Federation of the United Kingdom and by the Empire Forestry Association).

PERCY PRESTON, Esq. (Nominated by the Carpenters' Company).

WALTER BIRCH, Esq., Messrs. Wm. Birch, Ltd.
W. H. SADGROVE, Esq., Messrs. Sadgrove & Co.
(Nominated by the National Federation of Furniture Manufacturers).

Major RALPH J. HOLLIDAY, M.C., Messrs. Holliday & Greenwood, Ltd.
H. T. HOLLOWAY, Esq., Messrs. Holloway Bros. (London), Ltd.
(Nominated by the Institute of Builders).

Sir KEITH PRICE, Messrs. Price & Pierce, Ltd.
J. P. FRASER, Esq.
(Nominated by the Empire Forestry Association).

J. W. LORDEN, Esq., M.P., Timber Sub-Committee, Empire Development Parliamentary Committee.

W. LAWTON GOODMAN, Esq., Messrs. Whitlock Motors, Ltd. (Nominated by the Institute of British Carriage and Automobile Manufacturers).

WYNDHAM R. DUNSTAN, Esq., C.M.G., LL.D., F.R.S.

Dr. S. E. CHANDLER (*Secretary*).

[In addition to the Committees in which their names are included, the Chairman of the Executive Council and the Director of the Imperial Institute are *ex-officio* Members of all Committees.]

LIST OF STAFF

Director: WYNDHAM R. DUNSTAN, C.M.G., M.A., LL.D., F.R.S.

Secretary to the Executive Council and Administrative Assistant to the Director: H. M. LIDDERDALE, B.A. (Oxon).

Assistant Secretary and Establishment Officer: Commander the Hon. SERELD HAY, O.B.E., R.N. (ret.).

Scientific and Technical Research Department and Technical Information Bureau.—*Superintendents:* H. BROWN; E. GOULDING, D.Sc. (Lond.), F.I.C.; S. E. CHANDLER, D.Sc. (Lond.), A.R.C.Sc., F.L.S. (*Acting*); R. ALLEN, M.A. (Cantab.), B.Sc. (Lond.), M.I.M.M. *Assistant Superintendents:* S. J. JOHNSTONE, B.Sc. (Lond.), A.I.C.; J. R. FURLONG, Ph.D. (Würzburg), A.I.C. *Principal Assistant:* O. D. ROBERTS, F.I.C.

Library.—*Officer in Charge:* H. J. JEFFERY, A.R.C.Sc., F.L.S. (*Acting*).

Public Exhibition Galleries.—COLONIAL AND INDIAN COLLECTIONS: *Senior Technical Superintendent:* H. SPOONER (*Acting*).

Other Officers, Scientific and Technical Staff

H. BENNETT, B.Sc. (Lond.).
G. S. BOULGER, F.L.S., F.G.S.
F. BOULTON.
G. T. BRAY, A.I.C.
W. S. DAVEY.
F. L. ELLIOTT, A.I.C.
A. T. FAIRCLOTH.
F. FERRABOSCHI, M.A. (Cantab.), A.I.C., F.C.S.
R. C. GROVES, M.Sc. (Birm.), A.I.C.
E. HALSE, A.R.S.M., M.I.M.M.
P. HARRIS, B.Sc. (Lond.).
G. E. HOWLING, B.Sc. (Lond.).
H. T. ISLIP, A.I.C., F.C.S.
A. B. JACKSON, A.L.S.
B. E. LONG, B.A. (Cantab.).
F. MAJOR, B.Sc. (Lond.), A.I.C.
G. MARTIN, B.Sc. (Birm.).
E. C. MOORE.
J. A. NELSON, B.Sc. (Lond.).
F. W. ROLFE.
P. F. C. SOWTER, B.Sc. (Lond.), A.R.C.Sc., A.I.C.
W. O. R. WYNN, A.I.C.

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

The following summaries have been prepared from a selection of the Reports made by the Director of the Imperial Institute to the Dominion, Colonial and Indian Governments.

SOUTH AMERICAN OIL SEEDS

DURING recent years considerable attention has been given to South America as a possible source of commercial supplies of oil seeds yielding oils and fats of technical importance. A large number of oil seeds from that country have been examined from time to time at the Imperial Institute, and the results of some of these investigations have already been published (cf. this BULLETIN, 1917, **15**, 479; 1919, **17**, 186; 1920, **18**, 168, 172; Bray and Elliott, *Analyst*, 1916, **41**, 298), whilst papers on the same subject by other authors have also appeared in the *Analyst* (Bolton and Hewer, 1917, **42**, 35; Bolton and Revis, 1918, **43**, 251).

Through the courtesy of Mr. T. B. Woodward, of Liverpool, four further varieties of South American oil seeds have been received at the Imperial Institute for investigation. The results of their examination have been published recently by G. T. Bray, A.I.C., and H. T. Islip, A.I.C., of the scientific staff of the Imperial Institute (*Analyst*, 1921, **46**, 325), and are reproduced in the following pages.

"*Cupu*" *Seeds*

These seeds are derived from *Theobroma grandiflorum* (N.O. Sterculiaceæ), a tree which occurs in the district of the Upper Amazon and in the province of Para. The seeds are flat and roughly ovate, with a slight odour resembling that of cocoa. They consist of a thin, brittle,

closely adhering, reddish-brown husk, covering a moderately soft, pale brown, oleaginous interior. The average dimensions of the seeds were 1·0 in. long, 0·8 in. broad and 0·25 in. thick, whilst the average weight of a seed was 2·2 grams.

The fat extracted with petroleum spirit was creamy-white, of rather soft consistence, and practically devoid of taste or odour. From the chemical examination this fat apparently resembles cocoa butter. Cupu fat, however, is softer than cocoa butter, and lacks its brittleness and odour. It could probably be used for edible purposes.

The residual meal contained 1·0 per cent. of an alkaloidal body which gave the murexide reaction and was probably theobromine. This amount of alkaloid corresponds to 0·5 per cent. on the original seeds.

Hymenæa Fruits

These fruits are derived from a species of *Hymenæa*, probably *H. Courbaril* (N.O. Leguminosæ), which is found in South America and in Jamaica. The sample examined consisted of large brown, rough, shiny pods about 5·7 in. long, 2·3 in. broad, and 1·2 in. thick. The pod-cases were about 0·2 in. thick, and were very hard and brittle. The pods contained on an average seven seeds embedded, generally together with a few small lumps of pale yellow resin, in a pale reddish-brown, soft, mealy material, which clung tenaciously to them. The seeds were of flattened oval shape, and had a very hard, tough, smooth, chocolate-coloured seed coat. The kernels were very hard, and of a pale cream colour internally. The average weight of a seed was 3 grams. The pods consisted of: pod-cases, 74 per cent.; mealy material and resin, 6 per cent.; and seeds, 20 per cent.

The oil extracted from the seeds with petroleum spirit was nearly colourless, and had a rather unpleasant odour. Owing to the small amount of material available, the constants of the oil were not determined.

The residual meal was pinkish-brown and possessed a pleasant agreeable taste, but was found to be rather poor in protein. The mealy substance surrounding the

seed is palatable, and is stated to be eaten by the natives of the West Indies.

Parinarium Seeds

The fruits of several species of *Parinarium*, belonging to the natural order Rosaceæ, are already known to be oleaginous. The seeds of *P. Mobola* have been imported as an oil seed into Europe under the name of "Mabo" seeds, whilst the oil from *P. senegalense* seeds is occasionally used in Senegal for soap-making.

The present sample consisted of egg-shaped fruits with a reddish-brown, rough surface, marked by small irregular cracks. The dimensions of the fruits were from 2 to 3 in. long, and from 1·4 to 2·0 in. in diameter at the widest part. The shell, from 0·3 to 0·45 in. thick, was very tough and fibrous, and not easily removed from the kernel. The kernels were yellow and oily, but of firm consistence, and split easily, disclosing a long central cavity. They were covered with a light greyish-brown inner fibrous skin and a reddish-brown outer skin, both of which were readily detachable. The odour of the kernels was characteristic and unpleasant. The fruits were composed of 79 per cent. of shell and 21 per cent. of kernels. The average weight of a fruit was 29·3 grams, and of a kernel 7·6 grams.

The oil extracted with petroleum spirit was a thick, viscid, dark brown oil, which on keeping became a soft semi-solid fat. It had a strong unpleasant odour. This oil differs considerably from a sample of "Po-yoak" oil from Sierra Leone examined at the Imperial Institute (this Bulletin, 1918, **16**, 38), which is probably derived from the nuts of another species of *Parinarium*. The latter had drying properties, and polymerised to a solid mass on heating to 300° C. for twenty minutes in an oil-bath. The "Po-yoak" seeds are more globular and have a thinner shell than this South American variety.

The residual meal had an unpleasant bitter taste.

Platonia Seeds

These seeds were derived from a species of *Platonia* N.O. Guttiferæ). They were somewhat irregular in shape,

but their predominating form was a flattened ovoid, slightly concave on one side, their average dimensions being 2 in. long, 1 in. broad and ⅝ in. thick. The seeds had a thin, closely adhering, tough brown skin, enclosing a firm oleaginous kernel, which varied in colour from greyish-white to brown, but in many seeds was brown throughout. The flesh in places showed minute cavities

	Theobroma grandiflorum seeds.	*Hymenaea Courbaril* seeds.	*Parinarium* species kernels.		*Platonia* species seeds.
			South America.	Sierra Leone.	
Composition:					
Moisture . . *per cent.*	8·2	11·5	3·4	8·7	3·2
Oil on material as received *per cent.*	48·7	6·4	74·2	58·3	75·0
Oil on material dried at 100° C. *per cent.*	53·0	7·2	76·8	63·8	77·5
Analytical Values of Oil:					
Melting-point, ° C.[1] . .	32·0	—	—	—	31·0
Solidifying point of fatty acids (Titer test), ° C. . .	48·1	—	41·6	48·3	50·1
Specific gravity . . .	0·8522[2]	—	0·905[3]	0·969[3]	0·8782[2]
Acid value	44·0	—	16·2	17·4	46·4
Saponification value . .	187·8	—	200·5	192·3	199·5
Iodine value (Hübl, 17 hours) *per cent.*	44·8	—	77·3	157·1	77·8
Unsaponifiable matter *per cent.*	0·91	—	0·76	0·7	3·63
Volatile acids, soluble[4] . .	0·08	—	2·68	0·2	0·13
Volatile acids, insoluble[4] .	0·12	—	0·52	0·4	0·37
Refractive index $[n]^{40}_{D}$ . .	1·456	—	1·469	—	1·469
Composition of Residual Meal:					
Moisture . . *per cent.*	9·9	11·0	7·4	12·2	9·2
Crude proteins . *per cent.*	18·7	7·1	24·7	12·1	14·3
Fat . . . . *per cent.*	7·0	7·0	7·0	7·0	7·0
Carbohydrates, etc. (by difference) . . *per cent.*	43·8	67·7	46·6	56·1	46·2
Crude fibre . . *per cent.*	14·3	5·5	8·2	8·9	13·4
Ash . . . . *per cent.*	6·3	1·7	6·1	3·7	9·9
Nutrient ratio[5]	1 : 3·2	1 : 11·8	1 : 2·5	1 : 6·0	1 : 4·4
Food units[6]	108	103	126	104	99

[1] *Open tube method.* [2] *At 100°/15° C.* [3] *At 15°/15° C.*

[4] *C.c. of* $\frac{N}{10}$ *potassium hydroxide solution required to neutralise the volatile acids from 5 grams of the oil.*

[5] *The ratio between the percentage of crude proteins and the sum of the percentages of starch and fat, the latter being first converted into its starch equivalent.*

[6] *The total obtained by adding the percentage of starch to 2·5 times the sum of the percentages of fat and crude proteins.*

containing brown resinous material. The average weight of a seed was 11·8 grams.

On extracting the seeds with petroleum spirit a dark brown solid fat was obtained of fairly firm consistence and having a slight aromatic odour.

The residue from the extraction with petroleum spirit yielded, on extraction with acetone, 3 or 4 per cent. of a soft brown resinous material. The residual meal was free from alkaloids and cyanogenetic glucosides.

Results of Examination

The table on page 4 gives the results obtained in the examination of these seeds and the oils extracted from them.

Conclusions

Of the four oil seeds described, " Cupu " (*Theobroma grandiflorum*) is the only one which can be considered as at all promising from a commercial point of view. The quantity of these seeds available is not known, so that it is not possible to state whether they can be exported in sufficiently large consignments to be of economic value.

THE OIL OF CAPE CHESTNUT SEEDS

The Cape chestnut (*Calodendron capense*, Nat. Ord. Rutaceæ), is a large tree, sometimes reaching a height of 60 feet, with a trunk 3 feet in diameter. According to Sim (*The Forests and Forest Flora of the Cape*) it occurs from the coast level up to an altitude of about 4,000 feet in all the forests from Swellendam through the Midland, Eastern and Transkeian Conservancies. It is seldom abundant in high forest, and is more frequent, though smaller, in open kloofs or in coastward scrub. The tree also occurs frequently in Natal, and it has been recorded from Zambesia and Central Africa. It produces a white timber suitable for box-making and planking, and has been stated to be one of the few indigenous trees which may prove worth cultivation. The seeds, which are bitter, and are not eaten even by monkeys or birds, contain an oil, a sample of which from East Africa was examined at

the Imperial Institute some years ago (cf. this BULLETIN, 1908, 6, 364). Seeds collected in the East London District of the Cape Province, where the tree is stated to be fairly plentiful, were received for examination in September 1921.

The seeds were black and angular, with shiny, crinkled, woody shells, the inner surfaces of which were of a pale pinkish-brown tint. The shell enclosed an irregular-shaped, cream-coloured kernel, partly covered with a thin, tightly adhering, light brown coat.

The seeds were composed of shell 57 per cent., and kernel 43 per cent. The average weight of the seeds was 1·1 grams, and of the kernels 0·5 gram.

The kernels extracted from the seeds contained 3·6 per cent. of moisture, and yielded on extraction with light petroleum 59·2 per cent. of a liquid oil, corresponding to a yield of 61·4 per cent. from the moisture-free kernels or 25·5 per cent. from the whole seeds.

The extracted oil was lemon-yellow, slightly cloudy, and had a faintly bitter taste. It was examined with the following results, which are shown in comparison with corresponding figures obtained at the Imperial Institute for the sample of oil prepared in East Africa, and also with those for cotton-seed oil.

	Present sample.	*C. capense* oil from East Africa.	Usual constant of cotton-seed oil.
Specific gravity at 15/15° C.	0·9219	0·9190	0·92–0·93
Acid value	0·4	27·0	—
Saponification value	192·6	192·0	191–196·5
Iodine value . . *per cent.*	108·7	98·4	100·9–116·9
Unsaponifiable matter . *per cent.*	0·5	2·1	—
Volatile acids, soluble	0·5	—	—
Volatile acids, insoluble	0·2	—	—
Solidifying point of fatty acids (Titer test)	26·8° C.	35·0° C.	32·2–37·6° C.
Refractive index at 40° C.	1·465	—	—

The meal left after the extraction of the oil from the kernels was a cream-coloured powder with a bitter taste. It was analysed with the following results, which are shown in comparison with corresponding figures for decorticated cotton-seed cake :

	C. capense meal (calculated for meal containing 7·0 per cent. of fat). *Per cent.*	Decorticated cotton-seed cake. *Per cent.*
Moisture	7·3	8·65
Crude proteins	40·2	40·25
Fat	7·0	7·93
Carbohydrates, etc. (by difference)	37·0	26·06
Crude fibre	3·9	10·16
Ash	4·6	6·95
Nutrient ratio	1 : 1·3	1 : 1·1
Food units	155	147

The meal contained no cyanogenetic glucosides, but a substance giving reactions similar to those of alkaloids was present.

The oil obtained by extracting the kernels of these *C. capense* seeds with light petroleum is similar in its constants to cotton-seed oil. It probably could not be used for edible purposes on account of its slightly bitter flavour, and might therefore be suitable only for soap-making or other technical uses, for which purpose it should realise a price about equal to that of cotton-seed oil (" technical refined soap oil ") which in January 1922 was quoted at 39*s*. per cwt. at Hull.

The residual meal is rich in proteins and contains only a low percentage of fibre. In nutritive value it is slightly superior to decorticated cotton-seed cake, but it has a bitter taste, and would therefore not be palatable to cattle. For this reason, and also on account of the presence of a substance giving an alkaloidal reaction, its use as a feeding-stuff cannot be recommended, and it could probably only be used as a manure.

If the seed is available in large quantities it may be remunerative to express the oil in South Africa and to employ the residual meal locally as a manure.

ERI SILK FROM EGYPT

In addition to the common mulberry silkworm (*Bombyx mori*), the caterpillars of a large number of moths yield silk which can be employed for spinning. Notable among these is the eri silkworm (*Attacus ricini*) of India, which feeds on the leaves of the castor-oil plant. This

silkworm is largely reared in Assam for the production of silk, and has also been introduced into other parts of India, as well as into Ceylon and other countries. A full account of the eri silkworm and of other wild or semi-wild silkworms will be found in this BULLETIN (1915, **13**, 87). In February 1921, three samples of eri cocoons, produced on a small experimental scale in Egypt, were sent by the Director of the Entomological Section, Ministry of Agriculture, for examination at the Imperial Institute. They were as follows:

No. 1. "*Grown at Ras el Khalio,* 1919."—This consisted of reversed cocoons. The original outer surface of the cocoons was creamy-white, whilst the inner surface was brownish, and in most cases showed dark discolorations. Some insect remains and debris were present.

No. 2. "*Unturned cocoons, grown at Ras el Khalio,* 1919."—These were unturned cocoons, generally of a creamy-white tint, but in many cases stained light brown externally. The inner surface bore dark brown discolorations. Some of the cocoons contained dead chrysalides and the remains of the larvæ of some small insect.

No. 3. "*Turned cocoons, grown at Cairo,* 1919."—These were reversed cocoons, generally similar to those of sample No. 1, but rather paler and less stained.

The cocoons and the silk which they furnished were examined in detail with the following results:

Average Weight of a Cocoon

No. 1 . . .	0·23 gram (as received).
No. 2 . . .	0·42 gram (as received), and 0·28 gram (after being freed from chrysalides and dirt).
No. 3 . . .	0·43 gram (as received).

Dimensions of Cocoons

	No. 1.		No. 2.		No. 3.	
	Length.	Diameter.	Length.	Diameter.	Length.	Diameter.
	in.	*in.*	*in.*	*in.*	*in.*	*in.*
Maximum	1·8	0·7	1·9	0·8	1·8	0·7
Minimum	1·4	0·5	1·4	0·6	1·5	0·5
Average	1·6	0·6	1·7	0·7	1·7	0·6

Diameter of Thread

	No. 1. in.	No. 2. in.	No. 3. in.
Undegummed	0·0011 to 0·0014	0·0011 to 0·0014	0·0011 to 0·0016
Average	0·00125	0·00121	0·00140
Degummed	0·0005 to 0·0007	0·0004 to 0·0007	0·0006 to 0·0008
Average	0·00062	0·00055	0·00071

The amount of moisture and the loss on degumming were determined after freeing the cocoons from debris and dirt, and the following results were obtained :

	No. 1. Per cent.	No. 2. Per cent.	No. 3. Per cent.
Moisture	8·0	8·2	8·0
Loss on degumming, expressed on moisture-free material	13·9	12·8	11·3

The silk obtained from the three samples was of similar quality and of normal appearance. It was not so readily degummed as mulberry silk, the parchment-like inner surface being very resistant to soap solution. The gum was, however, satisfactorily removed without impairing the strength of the silk, by boiling the cocoons with a 1 per cent. solution of washing soda, in quantity equivalent to 0·25 gram of washing soda (or 0·09 gram of anhydrous sodium carbonate) per 100 grams of raw silk.

The cocoons were submitted to the Imperial Institute Advisory Committee on Silk Production, who considered them to be of good quality and worth about 2*s.* per lb. for the ordinary cocoons, and 2*s.* 6*d.* per lb. for the reversed cocoons, delivered in the United Kingdom (July 1921). It was stated that the reversed cocoons would be preferable in the trade if they could be produced on a commercial scale.

The degummed silks obtained from the three samples were of similar character, and resembled in strength and lustre a sample of eri silk from East Africa previously examined at the Imperial Institute. The colour of the present material was, however, superior to that of the East African silk, and the diameter of the fibres was less variable.

A member of the Advisory Committee on Silk Production offered to purchase an experimental consignment for technical trial, at the prices quoted above, but accord-

ing to information received subsequently from the Director of the Entomological Section, sufficient cocoons for this purpose are not available in Egypt. Further, it is very doubtful whether the natives would take up the industry, and it appears certain that it would not pay to produce the cocoons for export at the prices offered.

OCHRES FROM JAMAICA

The samples of crude ochre from Jamaica which are the subject of this report were forwarded in July 1921, at the suggestion of the Imperial Institute, in order to ascertain whether marketable pigments could be prepared from them by suitable treatment.

The samples, as received at the Imperial Institute, were as follows :

Sample No.	Label.	Description.
1.	Trelawney-Burkes .	A brownish-red earth, containing a large proportion of clay, which was heavily stained with iron. The material was gritty to the touch owing to the presence of small lumps of hard clay and pieces of hæmatite, but it did not appear to contain any free silica.
2.	Trelawney-The Lot.	A light reddish-brown earth, generally similar to No. 1.
3	Trelawney-Comfort Hall	Very similar to No. 1, but of a more purplish tint.
4.	St. Elizabeth .	Similar to No. 1, but of a red colour and containing much iron oxide and not so much clay.
5.	Manchester . .	A pinkish-red iron-stained clay, containing gritty pieces of kaolinised quartz and felspar.
6.	St. Catherine (Point Hill)	This was indistinguishable from No. 4 (St. Elizabeth).
7.	St. Catherine (Hags Hill)	This was indistinguishable from No. 3 (Trelawney-Comfort Hall).

These ochres would not be suitable for commercial use in the crude state, and attempts were therefore made at the Imperial Institute to prepare improved products from them by a process of grinding and levigation. It was found, however, that the purification of the ochres by this means alone was not in all cases satisfactory, and they were therefore treated by the following method

described by Bleininger (*Technologic Paper* No. 51, *United States Bureau of Standards*) for the purification of clays.

The ochres were ground with small quantities of caustic soda solution, and were subsequently levigated, dilute sulphuric acid being added to the liquid containing the purified pigment in suspension in order to effect its precipitation. After preliminary experiments to ascertain the amount of caustic soda needed to give the best results, each of the crude ochres was treated by this method, and the purified pigments obtained were submitted to paint-making trials, with the results given in the following table:

Sample.	Yield of purified ochre.	Colour of dry purified ochre.	Colour of purified ochre when ground in oil for paint-making.
	Per cent.		
1. Trelawney-Burkes	95·6	Brown.	Brownish-red, dark.
2. Trelawney-The Lot	92·4	Light brown.	Reddish-brown.
3. Trelawney-Comfort Hall	94·5	Reddish-brown.	Reddish, similar to Venetian red.
4. St. Elizabeth .	86·5	Reddish-brown, slightly darker than No. 3.	Reddish, slightly browner and more gritty than No. 3.
5. Manchester .	52·9	Light pinkish-buff.	Reddish-brown, rather light.
6. St. Catherine (Point Hill)	94·4	Reddish-brown, rather dark.	Indistinguishable from No. 4.
7. St. Catherine (Hags Hill)	89·1	Brown.	Reddish-brown, slightly browner than No. 4.

Certain ochres are improved in colour by calcination, and in order to determine whether this would be the case with the present samples the materials as received were calcined for about an hour at a bright red heat with free access of air. Except in the case of sample No. 5 ("Manchester"), where calcination caused no improvement in the colour, the calcined materials were slightly brighter than the raw ochres, but the differences were not sufficient to add to the commercial value of the ochres.

From a consideration of the results obtained it appeared that it would not be profitable to treat the material No. 5 ("Manchester") owing to the small yield of the purified product obtainable, or No. 1 ("Trelawney-Burkes") on account of its inferior colour. It seemed possible, however,

that the pigments prepared by the caustic soda process described above from samples Nos. 2 and 3 (" Trelawney-The Lot " and " Trelawney-Comfort Hall "), No. 4 (St. Elizabeth), and Nos. 6 and 7 (St. Catherine) might be of commercial interest. Samples of the purified materials prepared at the Imperial Institute from the first three of these samples were selected as being representative, and were forwarded to manufacturers and dealers in ochres. The pigments were, however, regarded by them as being of very poor colour and strength, and unsuitable for the paint trade in this country, their value being estimated at less than £3 per ton.

The wholesale prices per ton in the United Kingdom at the present time for earth colours of good quality are approximately as follows: Indian red, £20; Venetian red, £15; Turkey red, £30; and purple red, £12.

The results of this investigation have shown that by suitable treatment refined pigments can be prepared from these crude ochres, but that the colour and strength of the products are not sufficiently good to enable them to be marketed profitably in the United Kingdom. It is possible, however, that the materials might find some application locally in Jamaica, and in this connection it may be mentioned that the samples from Trelawney-Burkes, Trelawney-Comfort Hall, and St. Catherine-Hags Hill could probably be purified sufficiently by simple levigation, whilst in the case of the remaining samples the crude materials should be treated with dilute caustic soda, and levigated as already described.

REPORTS BY THE IMPERIAL INSTITUTE COMMITTEE ON TIMBERS

BRITISH COLUMBIA TIMBERS—II

1. Results of Trials conducted by H.M. Office of Works

In the Committee's first report on British Columbia Timbers, published in this Bulletin (1920, **18**, 191), reference was made to the strength tests and practical

joinery trials which were being carried out by H.M. Office of Works with a view to the inclusion of the timbers tested in the official specifications of that Department, if the results proved satisfactory. At the date of the report the strength tests had proved very satisfactory, but the practical joinery trials were still in progress.

The Office of Works has recently informed the Imperial Institute that the joinery trials have now been completed. The results are quite satisfactory, and show that the timbers tested compare favourably with European joinery timbers.

As a result of the strength tests and joinery trials B. C. Douglas fir, B. C. spruce and B. C. hemlock are, therefore, now included in the official specifications as alternatives to European woods. The Director of Works states that it is not possible to specify that the Canadian woods shall be used exclusively, since the greater part of the work of the Department is carried out on a competitive basis. He states that Douglas fir should be used for ordinary doors, windows, skirtings, etc., while B.C. spruce and B.C. hemlock would be quite satisfactory for the rougher joinery work such as table-tops and shelving.

2. Report on the Prejudice in the United Kingdom against the Use of B.C. Douglas Fir

In forwarding to the Imperial Institute the foregoing results of the trials conducted by H.M. Office of Works, the Director of Works referred to the prejudice which exists in this country against the use of British Columbia woods and suggested possible causes for this state of affairs. In their first report on British Columbia timbers the Committee also referred to certain defects of B.C. Douglas fir.

The question raised is one of considerable importance to the lumber trade of British Columbia, and the Timbers Committee have therefore carefully considered the position and now submit their report.

The timber chiefly concerned is B. C. Douglas fir. From their personal experience, and from information supplied to them, the Committee are satisfied that a prejudice exists in this country against the use of Douglas fir for building construction purposes. The prejudice is

based upon certain defects commonly met with in the timber as received in this country. The most important of these defects are its susceptibility to dry rot and doat, and an alleged brittleness and liability to split. It is also regarded as unsatisfactory for painting on account of the grain showing prominently. Further, the timber has frequently arrived in this country discoloured and in poor condition.

As regards dry rot and doat, the objection to B.C. Douglas fir would appear to have some foundation in fact. These defects are to be attributed to two main causes, viz. (*a*) insufficient seasoning of the wood before shipment; combined with (*b*) the effects of the long voyage to this country before the opening of the Panama Canal.

The Committee understand that in British Columbia it is the practice to ship the timber green and often wet from the water, and that for financial and other reasons it is not possible for the B.C. mills to carry large stocks of timber in stacks for air seasoning before shipment. There is also the difficulty of climate in ordinary air seasoning as understood in this country. The Committee have little doubt that these circumstances, combined with the long voyage to this country, are responsible for the liability of the timber to dry rot and doat, but consider that the more favourable conditions resulting from the shorter voyage *via* the Panama Canal should result in an improvement in the condition of the timber when it reaches this country. They understand that such improvement has already been noted in shipments made *via* the Canal. At the same time, however, the Committee suggest that every effort should be made to season the wood before shipment, so far as circumstances permit. They are of opinion that, with proper treatment, B.C. Douglas fir will be found not more liable to dry rot and doat than other coniferous timbers.

As regards brittleness and splitting, the Committee consider that these objections are not of serious importance so long as sound timber is employed. The results of tests demonstrate the great strength of sound wood.

With reference to painting qualities, Douglas fir, on account of its strongly marked grain, is not so satisfactory

as other woods. Even with careful finishing and smoothing of the wood before painting, the grain becomes apparent in course of time.

As mentioned in the Committee's first report, shipments of Douglas fir arriving in this country occasionally contain a proportion of "woolly" timber, and pieces with unduly wide rings. The Committee consider that both these defects could be avoided by more careful selection and grading of the timber before export, and suggest that this should be carried out so far as possible. They are informed, however, that these faults are less frequent in B.C. Douglas fir than in American Douglas fir (Oregon pine).

EASTERN CANADIAN TIMBERS

In their enquiry into the possibilities of a wider use of Canadian woods in this country the Timbers Committee dealt in their first report with the woods of British Columbia (cf. this BULLETIN, 1920, **18**, 191). A copy of the report was forwarded to the High Commissioner in London for transmission to the Canadian Government in September 1920.

In the present report the Committee deal with the commercial timbers of the Eastern Provinces of Canada. These timbers include softwoods and hardwoods, and representatives of both these classes are well known to the trade in this country. The hardwoods are of considerable reputation and importance, but at the present time interest centres chiefly on the softwoods in view of the great demand for timbers of this class and the intrinsic merits of the woods themselves.

The timbers considered by the Committee are as follows:

SOFTWOODS

Spruces (*Picea* spp.).—The three principal species are white spruce, black spruce and red spruce, which are all shipped and sold as Canadian spruce.

Collectively, the eastern spruces form by far the most important Canadian timber imported into the United Kingdom and are the subject of a large and valuable trade.

In recent years the export to this country has declined slightly, owing chiefly to the high prices obtained for the timber in the United States and to the demand for the wood for paper-making.

The Committee are well acquainted with the practical qualities of Eastern Canadian spruce, and are of opinion that the wood merits a far wider utilisation in this country than obtains at present. The timber is freely used for house-building in Canada and in the United States, and is largely employed in Ireland and to a less extent in Scotland and in certain parts of England (more especially the north-western districts and the Midlands) for the same purpose. In the east and south of England (including London) the wood is used for the manufacture of boxes and packing-cases, but there would appear to be a prejudice in these latter districts against the use of the timber for other and more important purposes.

It is difficult to find adequate explanation of this prejudice, and the Committee have consulted the Practice Standing Committee of the Royal Institute of British Architects on the question. The results of the enquiries made by the Practice Committee in different parts of the country confirm the Timbers Committee in their view that the prejudice, which certainly exists, is in great measure unjustified. While Eastern Canadian spruce is inferior to Baltic redwood of good quality for certain purposes, it is superior to much of the inferior grades of redwood largely used in this country. A hindrance to the more extended use of Canadian spruce for building purposes is the fact that it is not easy to obtain the timber in the range of sizes and forms of manufacture (*e.g.* planed shelvings, floorings and matchings) required by the trade. The Committee have dealt more fully with the question of sizes in another part of the report.

It is also stated that Eastern Canadian spruce does not last well when used for outside construction purposes, and is difficult to work for joinery. The Committee, however, are of the opinion that spruce from Eastern Canada is well suited as a substitute for European white deal, and can be recommended for carcassing and construction work in houses and buildings, and for common fittings of all kinds.

Sizes in chief demand in this country up to the present time for Quebec spruce are 3 × 6 in., 3 × 7 in., 3 × 8 in., 3 × 9 in. and 3 × 11 in., with smaller quantities of 2½ × 7 in. There is also a good demand for the higher grade 1st and 2nd qualities in 3 × 7 in., 3 × 8 in., 3 × 9 in., 3 × 11 in. Lengths of chiefly 12, 13 and 14 ft. are preferred for the higher qualities; for the commoner qualities length is not so important, but a percentage of long lengths is desirable.

The chief sizes for spruce shipped from New Brunswick and Nova Scotia are 3 × 4 in., 3 × 5 in., 3 × 6 in., 3 × 7 in., 3 × 8 in., 3 × 9 in., 3 × 11 in. and 2½ × 7 in., in lengths of from 9 to 24 ft.

For railway waggon building the principal sizes required are said to be 2½ × 7 in. in lengths of 7, 14, 15, 16 and 21 ft.

The Committee desire to point out that, in addition to the sizes mentioned above, there is a large demand in the United Kingdom for the following dimensions in redwood (yellow deal) for general building purposes: 2 × 3 in. in lengths of 6 to 17 ft., the greater number averaging 13 ft.; 2 × 4, 2 × 4½, 2 × 5, 3 × 4½ in., in lengths of 6 to 25 ft., the bulk averaging 15, 16 and 17 ft., but with a fair proportion of longer lengths; 2 × 6, 7 and 9 in., 2½ × 7 and 9 in., in lengths of 6 to 24 ft. with the bulk averaging 11, 12 and 13 ft., but including a fair number of longer lengths. If Canadian spruce could be imported into the United Kingdom to compare in quality and manufacture with the above, there should be a reasonable market for the same, although it is probable that lower prices would have to be taken than for the equivalent sizes in redwood.

Red Pine (*Pinus resinosa*).—This wood, which is also known in Canada as Norway pine, is very similar in appearance and working qualities to Baltic redwood, with which it comes into sharp competition in the European markets. For some years past, the quantities exported to the United Kingdom have steadily diminished, owing to the competition of redwood received from Scandinavia and the more satisfactory prices obtained in the United States for the Canadian wood. The wood, however, is of excellent quality, though the sap is often discoloured, which is a

disadvantage. The Committee desire to point out that, subject to regular supplies being available at competitive prices, Canadian red pine of good quality would be readily acceptable in this country as a substitute for Baltic redwood. The best sizes are 3 × 9 in. and upwards. Small sizes are probably not so saleable.

Yellow or White Pine (*Pinus Strobus*).—This timber, described in Canada as white pine, is one of the best known Canadian woods, and has been largely used in the United Kingdom for many years. The greater part of the yellow pine reaching this country is derived from the Ottawa and Catineau Valleys, and is sold on the market as Quebec pine. Smaller quantities shipped from New Brunswick and Nova Scotia are marketed as Lower Port Pine, but this timber compares unfavourably as regards quality and manufacture with the pine shipped from the provinces of Quebec and Ontario.

Yellow pine is a soft, mild wood, easily worked to a fine, smooth finish and not liable to warp or split. The better qualities are well suited for all high-class work, and the finest grades have for many years been largely used by engineers' pattern makers. The wood is also used for the decks of yachts and for painted fittings in ships' cabins. The lower grades are well adapted for carpentry and certain classes of joinery.

Balsam Fir (*Abies balsamea*).—This wood when sawn to dimensions is difficult to distinguish from spruce, and cargoes of the latter timber often contain a proportion of balsam fir. The wood can be used in place of spruce for many purposes, but the Committee understand that the output is likely to decline for some time to come as a result of damage done to the balsam fir forests by insect pests during recent years.

Other softwoods considered by the Committee include:

Eastern Larch (*Larix laricina*).—This fine wood, which was formerly used in large quantities for shipbuilding in Lower Canada, is said to be little inferior to Douglas fir in strength and durability. It would doubtless be useful in this country for building construction and for other purposes, but the Committee are informed that there is no likelihood of any marketable timber being forthcoming for

export for many years in consequence of the destruction of the forests by insect pests between thirty and forty years ago.

Eastern Hemlock (*Tsuga canadensis*).—The hemlock timber of Eastern Canada is much inferior to the western hemlock (*T. heterophylla*) of British Columbia, and very small quantities have been exported to the United Kingdom. Owing to the poor quality of this wood the Committee fear that it is unlikely to find a satisfactory market in this country.

Eastern Cedar (*Thuya occidentalis*).—This cedar is closely related to the western red cedar of British Columbia (*Thuya plicata*). The Committee understand that the tree seldom reaches a large size in Eastern Canada, and can rarely be obtained free from rot. Under these circumstances the Committee consider that it is questionable whether a market could be found for the wood in the United Kingdom as sawn lumber.

Basswood.—Of Canadian non-coniferous softwoods familiar in this country, basswood (*Tilia americana*) is the most important. This useful wood, which should be distinguished from American or Canary whitewood (*Liriodendron tulipifera*), is employed in this country for a great variety of purposes, and is much liked on account of its ease of working combined with toughness, and its ability to retain its shape after seasoning. It is especially valued in the pianoforte trade. In order to obtain the best prices in this country the timber should be white ; preference is given to quarter-sawn stock.

Hardwoods

Birch (*Betula* spp.).—Several species are concerned, the most important being black or yellow birch (*B. lutea*), and white or paper birch (*B. alba* var. *papyrifera*). For many years the former timber has been exported in large quantities to this country, where it is extensively used for furniture and carriage-building.

White birch hitherto has been exported in small quantities only. The Committee understand that very large supplies of the timber are available, but up to the present it has not been exploited commercially to any

great extent. Considerable quantities are used in Canada and in the United States for the manufacture of hardwood floorings, furniture, etc., and also for bobbins.

The Committee understand that the export trade in white birch from Eastern Canada could be largely increased, and they consider that this wood should find a valuable market in this country.

Maple (*Acer* spp.).—The two principal commercial varieties of this wood are hard or rock maple (*A. saccharum*) and soft maple (*A. saccharinum* and *A. rubrum*), both of which are familiar in this country. The former is the more important and is largely employed for flooring, boot-lasts, rollers, etc. Of the figured varieties the best known is the bird's-eye maple, formerly used in large quantities for veneering and picture frame mouldings, and now employed for panelling and other decorative work in ships' cabins, railway carriages, etc., and also in the furniture trade. "Blister" or curly maple has been also used for similar purposes.

The Imperial Institute is informed that considerable difficulty has been experienced by the Northampton boot-last trade in obtaining adequate supplies of rock maple for manufacture of boot-lasts, and that the trade would welcome efficient substitutes for rock maple. It is understood that the scarcity of supplies has been due chiefly to the increasing demand for the wood in Canada and the United States, where the wood is largely used by motor-car manufacturers, who are prepared to pay high prices.

Beech (*Fagus grandifolia*).—Canadian beech has been imported into the United Kingdom in small quantities. The Committee consider that the timber would probably find a market in this country for chair and couch frames if the price does not exceed that of English beech.

Elm (*Ulmus* spp.).—The two principal varieties are white (soft or grey) elm (*U. americana*) and rock elm (*U. racemosa*). The former is extensively used in America for furniture, cooperage and many other purposes, and is imported into this country chiefly for the manufacture of coffins. Rock elm is a tougher wood and is well known in the United Kingdom, being largely used by barge and boat builders, and also for bent work, especially van tilt hoops.

Increased attention is being given to elm as a furniture timber in this country, and it is probable that Canadian white (soft or grey) elm would be found suitable for this purpose.

Conclusions

The Committee consider that the technical qualities of Eastern Canadian timbers are such as to warrant a far larger use of the woods in this country than obtains at present. As regards softwoods, spruce and red pine (notably the former) are most likely to find an extended market since they form admirable substitutes for Baltic white and red deal respectively. Yellow (white) pine is well known, but should also be more extensively used than at present. Hitherto, Eastern Canadian spruce and red pine have been well known and appreciated in certain parts of the United Kingdom, while in other districts this has not been the case. This state of affairs is probably due for the most part to geographical factors, since, in general, the respective areas in which Canadian and European woods find readiest acceptance are in the neighbourhood of the principal importing and distributing centres of the timbers. In view of the intrinsic merits of the woods, however, the Committee consider that there appears to be no valid reason why Eastern Canadian softwoods should not be used throughout the country as alternatives to European woods of the same class, provided that the Canadian timbers can be landed in the United Kingdom at a price to compete with woods imported from the Continent. Ultimately, cost is the controlling factor.

The Committee desire to point out that if Canadian softwoods are to compete more successfully with European timbers, it is important that they should be well seasoned and that the sawn lumber should maintain a high standard of manufacture and accuracy of measurement which has sometimes been lacking in the past. The timber should also be available in as full a range of sizes as possible.

In their report on British Columbia timbers the Committee referred to certain practical joinery trials which were being undertaken by H.M. Office of Works at the instance of the Imperial Institute. As a result of the

satisfactory conclusion of these trials the B.C. timbers dealt with by the Committee have now been included in the official specifications of H.M. Office of Works as alternatives to European softwoods. The Committee are informed that the same facilities are offered to all other Canadian timbers, *i.e.* including those from Eastern Canada; and that H.M. Office of Works has no objection to the use of these woods by contractors if the woods conform to the official standards of quality. The Committee also understand that Canadian red pine, yellow (white) pine and spruce have been accepted by the War Office as alternatives to European softwoods.

GENERAL ARTICLES

SUMMARY REPORT ON THE WORK OF THE IMPERIAL INSTITUTE FOR INDIA

This report gives a general account of the more important Indian work conducted during the three years 1919–1921 in the principal branches of the Imperial Institute, including the Scientific and Technical Department, the Technical Information Bureau, the Committees of the Indian Trade Enquiry, the Advisory Technical Committees of the Institute, and the Indian Section of the Exhibition Galleries.

I. TECHNICAL AND COMMERCIAL INVESTIGATIONS

Foodstuffs

Madagascar Beans.—The ordinary large butter beans consumed in this country are produced in Madagascar and are consequently usually known as "Madagascar beans." The plant yielding them is a variety of *Phaseolus lunatus*. Five samples of these beans, representing the 1918 crop grown from seed supplied by the Imperial Institute, were received from the Deputy Director of Agriculture, Northern Circle, Mandalay, in continuation of previous investigations with a view to the improvement

of the production of beans in Burma. The beans were fairlyplump and in good condition and compared favourably with the crops obtained in the earlier experiments. The yields of prussic acid were in general higher than in the case of the 1917 crop, but the amounts were negligible and would be quite harmless. The beans were, however, slightly inferior both in colour and size to the ordinary Madagascar beans sold in the United Kingdom and would realise somewhat lower prices (cf. this BULLETIN, 1920, **18**, 471).

Pe-nge Beans.—These are small white beans produced by another variety of *Phaseolus lunatus*, which was introduced into Burma from the United States in 1914–15. Three samples received in 1921 were on the whole the best so far produced in the country and were valued at about £10 per ton, c.i.f., London (June 1921). Beans of this variety representing the earlier crops grown experimentally in Burma were described in this BULLETIN (1920, **18**, 473).

White Rangoon Beans.—One of the numerous kinds of beans grown commercially in Burma is the white Rangoon bean, which is also a variety of *Phaseolus lunatus*. These beans, known in the vernacular as "Pe-byu-gale," are frequently sold in the United Kingdom as "small haricot beans," but are distinct from the true haricot bean derived from *P. vulgaris*. A sample of white Rangoon beans grown from Burma seed at the Jorhat Government Farm, Assam, was forwarded by the Agricultural Chemist to the Assam Administration for examination in comparison with Rangoon beans (*loc. cit.*, p. 474). The beans were similar in size and general character to samples of the same variety received at the Imperial Institute from Burma, but were somewhat inferior in appearance owing to the presence of discoloured and shrivelled beans. The product would realise approximately the market price of white Rangoon beans, which were currently quoted at £20 per ton, ex store London (July, 1919).

Coloured Haricot Beans.—Two samples of haricot beans (*Phaseolus vulgaris*) grown experimentally at the Mandalay Farm, Burma, were examined. One, with a

black seed-coat, was found to contain a higher percentage of proteins than the ordinary white haricot of commerce, and would have a higher feeding value, whilst the other, which had red markings, had the same composition as ordinary haricots. The colour of the seed-coats would be a drawback to the sale of these beans for human consumption in the United Kingdom, but it was considered that they would find a market as a cattle food at about £6 to £8 per ton, ex warehouse, London (June, 1921).

Green Gram.—A sample of green gram (*Phaseolus Mungo*), grown at the Mandalay Farm, proved to be similar to the ordinary green gram imported into the United Kingdom for use in the manufacture of compound feeding cakes, and would probably realise about £6 to £8 per ton, ex warehouse, London.

Canavalia Beans.—A sample of these beans, grown experimentally at Mandalay, Burma, was examined. The results of analysis showed that they were of good nutritive value, but there is some uncertainty regarding their suitability for use as a feeding-stuff for livestock, as Canavalia beans have been sometimes suspected of being poisonous.

Lathyrus sativus Seeds.—The Economic Botanist to Government, Punjab, forwarded for investigation a sample of these seeds which had been reported to cause paralysis of the limbs among the inhabitants of the Dera Ghazi Khan District when used as an article of food. On chemical examination at the Imperial Institute they were found to be free from alkaloids and cyanogenetic glucosides. Previous attempts made at the Imperial Institute to isolate a toxic constituent from Lathyrus seeds gave negative results, and the cause of the remarkable effects often produced when these seeds are largely eaten is still uncertain. Particulars were supplied to the Economic Botanist of the results of the investigations which have been carried out with the seeds, from which it appears that when they are used only as a small part of the diet no harmful effects are likely to occur and that "Lathyrism" may therefore prove to be a deficiency disease.

Wheat.—Valuations and opinions as to the relative milling qualities of a number of wheats grown in the

Southern Shan States were obtained for the Deputy Director of Agriculture, Northern Circle, Burma, for guidance in connection with future trials for cultivation.

The Imperial Institute was consulted by the Department of Agriculture in Burma as to the possibility of producing white flour from the red macaroni wheat grown at Padu, either alone or in admixture with white wheat from the Shan States. A sample of each kind of wheat was forwarded from Burma, and it was found that they differed very little in their chemical composition, but that the character of the glutens varied considerably. Information was supplied by the Imperial Institute as to the milling methods which would be required in order to produce white flour from the red wheat, and it was pointed out that the feasibility of carrying out the operations involved in India would depend on the equipment of the existing mills.

Jam, etc.—The Madras Government are establishing a small experimental factory at Coonoor for the investigation of methods of preserving fruit as jam, etc., and of manufacturing pickles and sauces, with a view to subsequent demonstrations and the publication of the results obtained.

The advice of the Imperial Institute regarding certain technical difficulties which had arisen in the course of preliminary work was sought by the Manager of the factory while on leave. Information was supplied regarding pectins and other materials used to promote gelatinisation in jam manufacture and as to the preservation of jams from moulds and ferments.

Other foodstuffs dealt with included: Dari, rice and rice offals, peas and beans, val seeds, mangoes, tea and coffee.

Essential Oils

Patchouli and Palmarosa Oils.—In continuation of a previous investigation relating to the improvement of the essential oils produced in the United Provinces and to the marketing of the oils in the United Kingdom, further samples of Patchouli and Palmarosa oils were forwarded for examination and valuation (cf. this Bulletin, 1920,

18, 342, 346). These oils are largely employed in perfumery, palmarosa oil being produced in India, and patchouli oil in India and the Straits Settlements.

Both oils were of good quality, but the aroma of the Palmarosa oil was not quite equal to that of the earlier sample. As these oils were stated to be available in commercial quantities the Imperial Institute furnished samples to a number of firms in London, several of whom expressed their willingness to purchase consignments. The names of these firms were sent to India with the report in order that the producers might communicate with them.

Boswellia serrata.—When incisions are made in the stems of this tree, a resinous material exudes which on distillation yields a volatile oil leaving a residue composed of a resin and a gum. Investigations carried out at the Imperial Institute (cf. this BULLETIN, 1919, **17**, 149) showed that the oil could be used in paint and varnish making in place of ordinary turpentine oil, whilst the resin forms an excellent substitute for ordinary American rosin. The gum is partially insoluble, which precludes its employment for many of the purposes to which gum arabic is put.

A company in Cawnpore, who proposed to take up the commercial preparation of turpentine, rosin and gum from *Boswellia serrata* were given information as to the type of plant suitable for the purpose, and as to the marketing and probable prices of the products.

Other Enquiries relating to Essential Oils.—Information was supplied to an enquirer in Nellore regarding the cultivation of essential oil plants and the production of the oils, together with the names of firms who make stills suitable for the purpose.

Particulars as to apparatus for the distillation of essential oils, and the names of makers of the plant, were supplied to the Industries Bureau, Coonoor, Madras.

In connection with the disposal of ginger produced in Travancore, information was furnished to the Director of Industries regarding the present demand for ginger oil on the London market, and as to the general prospects of this product.

Oil Seeds

Safflower Seed.—The safflower plant is grown for its seed mainly in India and Egypt, the oil obtained by crushing the seed being largely used in those countries for edible purposes (cf. this Bulletin, 1916, **14**, 98).

A sample of safflower seed, grown experimentally at Mandalay Farm, was forwarded by the Deputy Director of Agriculture, Northern Circle, Burma, for examination and valuation. The seed was of good quality and yielded the usual amount of oil, which was of normal character. The sample was valued in London at about £18 to £20 per ton delivered at United Kingdom ports (May, 1920). Seed of similar character would be readily saleable if available in commercial quantities.

An enquiry was also received from the Director of Commerce and Industry, Baroda, regarding machinery for pressing kardi (safflower) seed for the production of oil. This operation presents considerable difficulties, the chief problem being the removal of the husks from the seed prior to pressing. Recommendations as to suitable machinery both for removing the husks and pressing the seed were made to the Director of Commerce and Industry, who was also furnished with estimates of the cost. Subsequently arrangements were made for preliminary trials on a manufacturing scale to be carried out in this country with selected machinery, with a view to testing the capabilities of the plant before orders are placed.

Linseed.—Samples of " common " and " white " linseed were forwarded by the Deputy Director of Agriculture, Northern Circle, Burma, for examination and valuation. The samples, which had been grown at the Mandalay Farm, consisted of plump ripe seed of fair size and good colour, with a small amount of stalk. Seed of both varieties would be saleable in the United Kingdom, but as the " common " linseed only gave a moderate yield of oil of rather poor quality it would realise a somewhat lower price than ordinary Calcutta linseed, which was currently quoted in London at about £46 per ton (November, 1919). The " white " linseed, however, gave a large

yield of oil of good quality and was valued at £48 10s. per ton in London at that time.

Perilla Seed.—In view of the increasing demand by British manufacturers for drying oils, the Imperial Institute suggested to the Director of the Botanical Survey of India that the cultivation for its seed of *Perilla ocimoides* might be extended in India with a view to an export trade. At present Perilla seed is only produced on a commercial scale in Manchuria, China and Japan, the extraction of oil from the seed being carried on mostly in the last-named country. As a result of the suggestions made, samples of Perilla seed from the Khasia Hills, the Naga Hills and Manipur were forwarded for examination. The samples were found to be of good quality and to give satisfactory yields of oil. The oil is suitable for use in paint and varnish making and for other purposes where a drying oil is required, and its value would depend on the current price of linseed oil. There is no doubt that a ready market will be available for Indian Perilla seed if it can be offered in commercial quantities, and enquiries on this point are now being made in India.

Soy Beans.—A brief account of the cultivation and utilisation of this useful product has been given in this BULLETIN (1909, **7**, 308; 1910, **8**, 40). Most of the soy beans entering commerce are produced in Manchuria. They are only grown to a small extent in India at present and in most parts of the country the cultivation of the crop has not yet passed the experimental stage. At the request of the Deputy Director of Agriculture, Northern Circle, Burma, information was furnished as to the varieties of soy beans most suitable for the British market. Samples of the varieties recommended were supplied for cultivation trials in Burma.

Indian Kapok Seed.—In connection with the utilisation of Indian kapok (*Bombax malabaricum*) referred to below, the Director-General of Commercial Intelligence was asked to forward a supply of the seed which is obtained in the preparation of the floss, in order that its value as an oil seed might be determined. The recorded information on this point was not very definite owing to little distinction having been drawn between the

seeds of Indian kapok and of true kapok (*Eriodendron anfractuosum*).

The seed was examined at the Imperial Institute and not only gave a higher yield of oil than that generally obtained from commercial Java kapok seed, but the oil appeared to be of better quality (cf. this BULLETIN, 1920, **18**, 335). Oil-seed crushers to whom samples of the seed and oil were submitted considered that Indian kapok seed would be likely to find a ready market in the United Kingdom at prices equal to or higher than that realised by commercial kapok seed (£15 per ton in November, 1920).

The residual meal left after extraction of the oil was also found to be a more valuable feeding-stuff than commercial Java kapok cake and to have a higher nutritive value than undecorticated cotton-seed cake. As the seed appears to be a promising source of oil and feeding cake, the Imperial Institute suggested that enquiries should be made in India as to the quantity available for export and the price at which it could be offered in London, and also that a trial consignment should be forwarded here for sale.

Toria Rape Seed.—Many varieties of rape are grown in India, the seed of which is used extensively in the country as a source of oil, whilst large quantities are exported. The kinds most commonly cultivated are sarson (Indian colza), with white, yellow or brown seeds, produced mainly in the United Provinces and the Punjab; toria (Indian rape), with smaller seeds of a bright brown colour, which is grown in the same two provinces, and more extensively in Bengal and Bihar; and rai (Indian mustard), with small brown seeds, largely grown in Bengal and to a less extent in the other provinces. The forms mainly exported are sarson and toria.

Six samples of toria rape seed were forwarded by the Professor of Agriculture, Lyallpur, Punjab, for examination and report on their relative values. On extraction with light petroleum the seeds all gave yields of oil about normal for Indian rape seed, and examination of the oils indicated that their constants corresponded closely with the figures recorded for commercial rape oil. Toria

rape seed has long been dealt with by oil mills in the United Kingdom, and consignments of seed of the quality of these samples would probably be saleable at the current price for Indian rape seed, viz. £21 to £22 10s. per ton in London (September, 1921).

African Oil Palm Cultivation.—Particulars as to soils, climatic conditions, etc., suitable for the cultivation of the African oil palm were furnished to a planter who contemplated taking up the industry on a commercial scale in the Bombay Presidency.

Sunflower Seed Oil.—References to literature regarding sunflower seed and oil, together with particulars as to the marketing and commercial value of these products in the United Kingdom, were supplied to the Deputy Director of Agriculture, Southern Division, Dharwar.

Other oils and oil seeds dealt with included: Mowra seed, oil and meal; cashew nuts; niger seed; sesame seed; candle-nut oil; tea-seed oil; rape seed and oil; date-stone oil; seeds of *Aleurites Fordii*; *Schleichera trijuga* seed; margosa seed; kanjin oil; coconut oil; ghi.

FIBRES

Jute (Corchorus olitorius).—Six samples of this fibre, representing the results of selection experiments conducted at Narainganj and Chinsurah by the Fibre Expert to the Government of Bengal were examined in order to ascertain whether any chemical or other difference could be detected between them. No appreciable variation was found in the behaviour of the fibres towards chemical reagents, and the samples were very similar in appearance and general characters, except that Nos. 5 and 6 grown in a "Desi" district were grey, whilst Nos. 1 to 4 grown in a "Bogi" district were buff-coloured. One sample from Narainganj appeared to be rather superior to the others in lustre and strength, but in the opinion of fibre merchants two other samples were of somewhat greater value. The samples were valued at prices ranging from £65 to £80 per ton in London (July, 1919) (cf. this BULLETIN, 1919, **17**, 465).

Sunn Hemp.—This fibre, obtained from the stems o *Crotalaria juncea*, is used in the United Kingdom as a

substitute for European hemp in cordage manufacture. It is produced on the commercial scale only in India.

Seven samples of Sunn hemp, forwarded by the Fibre Expert to the Government of Bengal, were stated to have been specially prepared with a view to ascertaining the suitability of the fibre for use as a substitute for flax in the manufacture of canvas (*loc. cit.*, p. 462). The samples were found to be much softer than ordinary Sunn hemp, but not so strong, so that the softness had apparently been secured at the expense of strength. The results of the investigation indicated that the treatment to which the Sunn hemp had been subjected in its preparation had caused marked changes in its character and composition, resulting in loss of strength and partial disintegration of the material into short ultimate fibres. The treated fibre was somewhat inferior to flax, but its suitability for use as a flax substitute could only be settled definitely by carrying out actual spinning and weaving trials on a large scale.

Kapok.—The ordinary kapok used in this country as a stuffing material for upholstery and other purposes consists of the seed-hairs of the silk-cotton tree, *Eriodendron anfractuosum*, the best kind coming from Java. Indian kapok is a similar fibre obtained from a different tree (*Bombax malabaricum*). An investigation as to the suitability of machine-cleaned Indian kapok for use in life-jackets was commenced at the Imperial Institute in 1916 and the enquiry was continued in the period now under review.

It was shown previously, as the result of trials carried out at the Imperial Institute, that machine-cleaned Indian kapok is superior in buoyancy to Java kapok, which under the Board of Trade regulations can alone be used for making life-jackets (cf. this BULLETIN, 1919, **17**, 14). The Imperial Institute therefore suggested to the Board of Trade that the use of Indian kapok of good quality might be permitted for this purpose, and the Board agreed to consider the question if it were established, that properly cleaned and unadulterated Indian kapok would be regularly available in commercial quantities. Enquiries in India elicited the information that

large supplies of machine-cleaned kapok, equal in quality to the bales forwarded for examination, would be available annually from India, and the Imperial Institute then arranged with the Board of Trade for official tests of the floss to be carried out in the presence of a representative of the Institute. These trials gave satisfactory results, and the Board subsequently expressed their willingness to allow Indian kapok to be employed for this purpose provided that a definite and reliable standard of quality can be established and maintained. A conference with shippers of Indian kapok was accordingly arranged by the Institute to consider the best means for meeting the requirements of the Board of Trade, and further information has since been obtained from India on the various questions involved for submission to another conference which is to be held with officers of the Board and representatives of the trade (including importers of kapok and manufacturers of kapok life-jackets).

Cotton.—An application was received from the Deputy Director of Agriculture, Northern Circle, Burma, for an opinion as to the difference in value between a sample of Cambodia cotton grown in Burma and one of Burmese Wagyi. Both these cottons were of rather short staple for the Liverpool market. Although the Cambodia cotton was inferior in colour and in length of fibre to samples of that variety previously received from India, it was decidedly superior to the sample of Wagyi cotton and was regarded as worth 1*d.* per lb. in advance of the latter (June 30, 1921).

Cotton Stalks.—The possibility of utilising for paper-making the stalks left after the cotton crop has been harvested has been investigated with material from the Central Provinces and the Punjab (cf. this BULLETIN, 1921, **19**, 13). In both cases the stalks furnished paper pulp of fair quality. In view of the importance of the question to the cotton-growing industry, it was suggested that large scale trials should be carried out, preferably at paper mills in India, with cotton stalks alone and also in admixture with other materials, in order to determine definitely whether it would be remunerative to use them locally for paper-making.

Experiments were also carried out to ascertain the nature and yields of the products obtainable from the stalks by dry distillation (*loc. cit.*, p. 17). The feasibility of distilling them successfully on a commercial scale would depend on finding local markets for the products (acetic acid, wood naphtha, tar and charcoal) and on the prices obtainable for them.

Talipot Palm Leaf-stalks.—The talipot palm or fan-palm of South India (*Corypha umbraculifera*) occurs wild on the Malabar Coast and also in Ceylon, and is cultivated in Bengal and Burma. At the request of the Divisional Forest Officer, Southern Division, Kanara, the leaf-stalks of the palm were examined as a paper-making material, and were found to give a fairly good yield of pulp which furnished a strong brown paper suitable for wrapping purposes. Although it was found possible to prepare from the pulp a paper of fairly white appearance and good strength, the pulp bleached with difficulty and required a relatively large quantity of bleaching powder. It therefore seems doubtful whether the manufacture of white paper from talipot palm leaf-stalks would be remunerative.

Other enquiries on fibres included: Flax; hemp; Abroma and Bromelia fibres; the fibre plants of the Madras Presidency; cotton cultivation; "Pernambuco" cotton from Burma; the cultivation of jute in Cuba in its relation to the Indian jute industry; the possibilities of bamboo, cotton stalks, etc., for paper-making; and the establishment of paper mills.

DRUGS AND TOBACCO

Belladonna Leaves and Roots.—The chief constituent of belladonna is the alkaloid atropine, which has a wide application in medicine. The countries in which the plant is chiefly cultivated for its leaves and roots are Southern Germany, Switzerland, and France.

In connection with the shortage of belladonna leaves and roots during the war, several samples were received from the United Provinces in order that their quality and commercial value in the United Kingdom might be determined.

(1) A sample of dried belladonna root forwarded by

the Superintendent of the Kumaun Government Gardens was well prepared and of fairly satisfactory quality, but contained slightly less than the usual quantity of alkaloid. Similar material would find a market in the United Kingdom, but would have to compete with English and other European supplies, which were quoted at 1*s.* 10*d.* to 2*s.* 6*d.* per lb. (July, 1919) against 6*s.* to 8*s.* per lb. in 1917.

(2) A bale of belladonna leaves was forwarded by the Secretary to Government, United Provinces, for sale in London and was disposed of by the Imperial Institute at the price of 2*s.* 6*d.* per lb. (October, 1919). The leaves contained a lower percentage of alkaloid than a sample previously received from the United Provinces, but sufficient to satisfy the requirements of the British Pharmacopœia. The price realised for the leaves was regarded as very satisfactory in view of the market conditions prevailing at the time of sale.

(3) Samples of powdered belladonna leaves and roots were also forwarded by the Superintendent of the Kumaun Gardens. The leaves contained about the usual quantity of alkaloid, but the amount in the roots was slightly below the average. The powdered materials would realise only about 3*d.* per lb. in advance of the prices of the whole leaves and roots, as most manufacturers in the United Kingdom prefer to grind the materials themselves, and it is therefore doubtful whether it would be remunerative to ship the powdered drugs from India. Information was, however, furnished by the Imperial Institute as to the method of preparation required, and it was suggested that if it were proposed to attempt to develop an export trade in these products small trial consignments should first be forwarded in order to test the market.

Datura Leaves.—In connection with enquiries received by the Imperial Institute during the war from alkaloid manufacturers as to sources of supply of suitable material for the production of scopolamine, the Director of the Botanical Survey of India forwarded at the request of the Imperial Institute a consignment of *Datura fastuosa* leaves for trial. The predominant alkaloid present in samples of *D. fastuosa* leaves previously examined at the Imperial

Institute was scopolamine, but in the case of this consignment from India the alkaloid was found to be principally hyoscyamine with only a small proportion of scopolamine. In view of the low yield of scopolamine obtained from the material in comparison with that from other solanaceous plants, the manufacturers considered it unlikely that *D. fastuosa* leaves of similar quality could be profitably shipped to the United Kingdom for the manufacture of alkaloids.

Strychnos Nux-blanda Seeds.—Of the large number of species of Strychnos occurring in the East, that of the greatest importance in medicine is *S. Nux-vomica.* The seeds of this plant and those of the ignatius bean (*S. Ignatii*) of the Philippines constitute the chief sources of strychnine. The seeds of a species of Strychnos from the Shan States, forwarded by the Deputy Director of Agriculture, Northern Circle, Burma, were identified at Kew as derived from *S. Nux-blanda.* Examination at the Imperial Institute showed that the seeds contain only a trace of alkaloid and are therefore of no value for medicinal purposes. In view of the statement that these seeds are sometimes used in India, in conjunction with other materials, as a dye, preliminary dyeing tests were carried out, but these indicated that the seeds were devoid of any appreciable tinctorial power and would be of no value as a dyestuff in the United Kingdom.

Recommendations were made to the Economic Botanist, Lyallpur, regarding the possibility of extending the cultivation of drug plants already grown in the Punjab, and the collection of information regarding other medicinal and economic plants of the country.

Other drugs dealt with included: Opium and opium alkaloids; senna; *Datura Metel*; *Artemisia maritima* as a source of santonin; Derris root; insect flowers; and camphor.

Tobacco.—Samples of three varieties of cigar tobacco forwarded by the Deputy Director of Agriculture, Southern Circle, Burma, were found to have been attacked by grubs and were not in suitable condition for commercial valuation. The leaves were imperfectly prepared and slightly mouldy, and although they burnt fairly well the flavour was un-

pleasant. Information was furnished by the Imperial Institute as to the types of cigar leaf required in the United Kingdom market, and it was suggested that further samples of well-grown and well-prepared leaves in good condition should be forwarded in order that the suitability of the tobaccos for sale in the United Kingdom might be determined.

Timbers

Timbers for Match Making.—The possibility of utilising Himalayan spruce and certain other Indian coniferous timbers for match making was considered, and samples of the timbers were submitted to a number of British match manufacturers, whose unanimous opinion was that none of them would be suitable for the manufacture of ordinary matches, though one firm stated that Himalayan spruce might be suitable for the manufacture of grooved pine splints. It would not be possible to interest British firms in the establishment of a match factory in India using this wood, and as it could not compete with the match-making timbers from other sources now available in the United Kingdom, the feasibility of making splints in India for export was investigated.

It was desired to carry out trials in India in this direction, but so far it has not been possible to obtain the experimental plant required. Grooved splints appear to be made by one firm only in the United Kingdom who use large continuous match-making machines of which the plant for cutting the sticks forms only a part. This firm has, however, undertaken to carry out tests with Himalayan spruce in the presence of a representative of the Government of India, and the Institute has suggested that a supply of the timber should be forwarded for this purpose and has offered to furnish an independent report as to the results of the trial.

Information was furnished to a firm of builders in London as to the suitability of Padauk wood for use in panelling; specimens of the timber and of the worked wood (doors, show-cases, etc.) were shown to the enquirers.

TANNING MATERIALS

Babul pods (Acacia arabica).—The pods of *Acacia arabica,* known in India as "babul" and in the Sudan as "sant," are largely used locally for tanning and attempts have been made in recent years to introduce them into the markets of the United Kingdom. A sample of these pods from the Punjab investigated at the Imperial Institute in 1918 compared unfavourably with similar pods received from the Sudan as regards the percentage of tannin present. A further sample was accordingly requested from India in order to ascertain whether this deficiency in tannin is characteristic of the pods produced in the Punjab. The amount of tannin present in the second sample (17·5 per cent. in the entire pods), although double that in the previous sample, is still considerably lower than the quantity found in the Sudan pods, which usually contain about 30 per cent. It is therefore doubtful whether *Acacia arabica* pods from India could compete successfully in the United Kingdom with the richer material from the Sudan and it was suggested that if any attempt were made to develop an export trade from India it would be desirable to ship the pod-cases freed from the seeds.

Tanning Extracts.—Information was supplied to the Department of Industries, Hyderabad, regarding the preparation of tanning extracts, as it was desired to engage in this industry in the State. References to technical literature on this subject were given, together with the names of manufacturers of the necessary plant.

Other tanning materials dealt with included: Cutch; mangrove extract; myrobalans extract; teri pods; Cæsalpinia pods; pomegranate skins; babul bark; turwad bark; kahua bark; aonla bark; and thawai bark.

MINERALS

Corundum.—In continuation of a previous enquiry as to the commercial value of corundum from Rewa State, the Imperial Institute arranged for technical trials to be carried out by manufacturers of abrasives with a consignment of the mineral sent by the State Geologist. The

report of the manufacturers confirmed the opinion expressed by the Institute as the result of the examination of a previous sample, that the material was unsuitable for abrasive purposes and would not be likely to find a remunerative market in this country in competition with supplies from other sources.

Sands for Glass Making.—An enquirer who proposed to undertake glass making in India was supplied with information regarding the occurrence in India of sands which might be suitable for the purpose.

Occurrence of Titanium in Katni Bauxite.—Information was furnished to the representative of a syndicate producing bauxite in India as to the mode of occurrence of titanium in Katni bauxite.

Micanite.—In connection with a proposal for the manufacture of micanite from waste mica in India, particulars of machinery used in the industry were given to an enquirer in Masulipatam.

Lignite.—Information was supplied to an enquirer in Bassein regarding the possible utilisation of lignite in Burma (1) for the production of power by means of a gas-producer plant, and (2) for the purpose of obtaining the maximum yield of oils and a coke residue by a distillation process.

Other subjects dealt with related to the sources and value of the following minerals from various parts of India: Coal; petroleum; bauxite; china clay; magnesite; barium carbonate; Iceland spar; gypsum; mica; talc; slate; jade; iron ores; chromium ores; wolfram; bismuth; tantalum and berryllium ores; monazite; onyx; precious stones.

MISCELLANEOUS

Casein.—Casein is a white, friable, solid albuminoid substance obtained from separated milk. Its use in industry has extended largely in recent years and considerable quantities are prepared in France, New Zealand, South America and elsewhere. The product is employed chiefly in the finishing of high-grade book and writing papers, as a dressing in the textile industry, for making waterproof cements and distemper paints, and in the

preparation of "casein solids," such as galalith, which are used as substitutes for horn and ivory.

A sample of casein prepared experimentally at the Gujarat College, Ahmedabad, was forwarded by the Director of Industries, Bombay, in order that its quality and commercial value might be determined. It was stated that Indian casein, which is prepared chiefly by crude methods, is regarded as of poor quality in comparison with that made elsewhere, and that the preparation of an improved product was under investigation in India.

The casein proved on examination to be of satisfactory composition, unusually free from mineral matter, and was regarded by commercial experts as of good quality and worth £65 per ton in London (January, 1920). Detailed information was furnished by the Imperial Institute as to the processes of manufacture followed in other countries, together with particulars of the apparatus required and the names of makers of such plant as could not be constructed locally in India.

Beeswax.—In 1915 the Imperial Institute drew the attention of the Government of India to the demand for pure Indian beeswax and to the necessity for taking steps to prevent the extensive adulteration (mostly with paraffin wax) which constituted a serious menace to the industry. Some difficulty arose in connection with the examination of samples subsequently forwarded by the Director-General of Commercial Intelligence, as the chemical constants of genuine unadulterated Indian beeswax had not been properly established and the wide variations recorded could not be accepted as authoritative. It appeared practically certain that adulterated products had been examined in some cases as pure wax, and a comprehensive series of authentic waxes (in the form of comb and not after being melted by native collectors) from different districts and from the different species of bees common in India was therefore requested.

The information furnished with the set of samples supplied in response to this request was not sufficient to enable a comparison to be made of the waxes from the different species of bee, but it is evident from the results of the investigation of these samples that Indian waxes

differ considerably in their constants from the waxes produced in most other countries, and that the tests generally used for detecting the presence of paraffin wax in beeswax are of little value in connection with Indian samples. In view of the considerable interest attaching to these investigations a detailed account is being published.

Ash of the Water-hyacinth.—The water-hyacinth (*Eichhornia crassipes*) is a troublesome weed in the canals and ditches of many parts of the tropics, and it has been suggested that the cost of its eradication would be reduced if a use could be found for the ash of the plant. A sample of the ash was forwarded by the Director of Industries, Burma, in order to ascertain whether it would be of any value as a fertiliser or for any other purpose. The chief constituent soluble in water was potassium chloride, but it is unlikely that the ash could be utilised remuneratively as a source of that material. It would, however, be suitable for local use as a potash manure.

Plantain Skin Ash.—A sample of plantain skin ash from the Cachar District, Assam, which was forwarded by the Officiating Commissioner, Surma Valley and Hill Districts, contained a much greater percentage of potash than a sample of plantain ash previously received from that province. The ash would be suitable for use as a potash manure, and if available in large quantities it could be employed as a source of potassium carbonate, of which it contains about 70 per cent. The residue remaining after the extraction of the water-soluble salts could be utilised as a phosphatic manure.

Saline Water.—A sample of saline water, also from the Cachar District, was submitted to chemical analysis, and the results compared with corresponding figures for certain other natural mineral waters. It was of a somewhat similar type to the alkaline saline water of Aix-la-Chapelle; but, owing to the relatively large quantity of sodium chloride present, it could not be used for the same medicinal purposes as the latter. The amount of sodium chloride present in the water, however, is not sufficient to indicate the presence of workable deposits of rock salt in the neighbourhood of the spring.

Thitsi Resin.—In connection with an enquiry regard-

ing the possibility of obtaining resin in Burma for use in the preparation of lacquers and varnishes for electrical fittings, particulars as to the sources of supply and properties of thitsi resin were furnished, together with the address of the Forestry Officer in Burma to whom application should be made for supplies of the product.

Rubber.—A sample of latex forwarded by the District Officer, Gaya, furnished a small yield of coagulum which contained only a low percentage of rubber. In view of the large supplies of corresponding materials available for the rubber industry this Indian product is not likely to be of commercial interest.

In connection with a proposal to start a rubber manufactory made by certain planters in Travancore, information was furnished to the Department of Industries in that State regarding the technical difficulties likely to be encountered in the manufacture of rubber goods.

The following additional enquiries relating to Indian products and their preparation were also dealt with:

Agriculture, Forest Products, etc.—Burma teak and other timbers; rubber planting; camphor; dandelion cultivation and supplies of dandelion seed for sowing; the eradication of lantana weed; lac and its cultivation; loofahs; pipal tree; manure for tea plantations; and mosquito blight.

Manufacturing Processes and Industries.—The destructive distillation of wood; manufacture of micanite; chromium salts; sulphate of soda; cyanamide; electrolytic manufacture of alkali; manufacture of salt in Burma; recovery of potash from plant ashes; nitrate of soda; Bassia flowers as a source of alcohol; preparation of essential oil of oranges; basket work; lac-ware toys; machines for making playing marbles; manufacture of "cereal" and other soaps; hydrogenation of oils, and plant required for the purpose; manufacture of indigo; preparation of eri silk; uses of intestinal skins; sulphuric acid; cotton-seed crushing.

II. INDIAN TRADE ENQUIRY

This enquiry, undertaken by the Committee for India and various Special Committees at the request of the Secretary of State for India, was continued and additional reports were completed.

The following reports were published during the period under review:

Hides and Skins.
Rice.
Oil Seeds.
Timbers and Paper Materials.
Jute and Silk.

The following reports are in course of publication:

Lac, Turpentine and Rosin.
Cinchona Bark and Myrobalans.

III. TECHNICAL COMMITTEES OF THE IMPERIAL INSTITUTE

Advisory Committee on Silk Production

Report on Indian Silk.—The Committee's Report on Indian Silk, in connection with the Indian Trade Enquiry (see above), has been published, together with a special report on the silk trade of the world.

The Committee have been assured of the interest taken by the Government of India in the question of sericulture, and have been informed by them of the preliminary steps which have already been taken in India to strengthen the industry.

Mysore Silk.—At the request of the Government of Mysore, the Committee arranged to examine representative samples of Mysore raw silk and to make recommendations as to the methods which should be adopted to render it more suitable for the English market. For the necessary technical trials the Committee have been supplied by the Mysore Government with a consignment of Mysore silk. The results of the preliminary examination of this silk by manufacturers show that it is of excellent quality, but not suitable for use in this market owing to the unsatisfactory manner in which it is reeled.

Representative samples of Mysore silk and cocoons have also been sent to the Imperial Institute for exhibition in the Indian Section of the Public Exhibition Galleries and for reference purposes.

At the suggestion of the Committee, consignments of

cocoons were sent by the Mysore Government to Kashmir, Calcutta and France for experimental reeling trials in modern filatures, in order to ascertain the intrinsic merits of the silk when properly reeled, and arrangements were made for the silk obtained to be sent to the Committee for examination and report.

Kashmir Silk.—With a view to the further improvement of Kashmir silk, the subject was discussed with the Director of Sericulture, Kashmir, when on leave in this country. The directions in which Kashmir silk should be improved for this market were considered.

The question of the prevalence of gum tacks in the silk was also considered and arrangements made for this defect to be investigated at the Imperial Institute. This has been done and a report furnished.

Representative samples of Kashmir cocoons, silk and waste silk have been sent to the Imperial Institute for exhibition in the Indian Section.

A consignment of Bulgarian silkworm eggs has been sent to the Director of Sericulture, Kashmir, for experimental cultivation. A smaller parcel of the eggs had been previously supplied to the Director of Sericulture for preliminary experiments and these proved successful.

Tussah Silk in India.—The prospects of establishing a Chinese Tussah silk industry in India have been considered. The silkworm concerned feeds upon oak leaves. Enquiries have been made in India, and from the replies received it appears that, with the possible exception of Burma (where, however, there is a religious objection to sericulture to be overcome) and the Punjab, there is little prospect of cultivating the Chinese worm in India.

The Committee considered that action should be taken upon the proposal made by the Government Entomologist in the Punjab that experiments with the worm should be carried out locally, and suggested that the Government Entomologist should obtain supplies of seed from China.

Advisory Committee on Timbers

Reports on Indian Timbers.—The Committee's Report on Indian Timbers, prepared in connection with the Indian Trade Enquiry, has been published.

Export Trade in Indian Timbers.—The Committee have interviewed Mr. R. S. Pearson, C.I.E., Imperial Forest Economist, who expressed his views as to the possibilities of an export trade in Indian timbers other than teak, especially to this country. Mr. Pearson took a favourable view of the situation, but time would be necessary for the organisation of the industry in India and for the appreciation of the qualities of the woods in this country.

Burma Timbers.—Mr. A. Rodger, Deputy Conservator of Forests, Burma, has given evidence to the Committee as regards Burma woods suitable for the English market. Mr. Rodger referred to several promising woods which were available in commercial quantities at satisfactory prices, and in which it seemed probable that an export trade will be built up before long. The Committee are dealing further with the question of the utilisation of Burma timbers in this country.

Indian Oaks.—In order to ascertain the suitability of Indian oak timbers for this market, in place of oak imported from foreign countries, arrangements were made with the Deputy Conservator of Forests, Punjab, when on leave in this country, for representative samples of different species of Indian oak to be sent to the Committee for report. A number of sample logs has recently been despatched to the Imperial Institute for this purpose.

Practical Trials of Indian Woods.—Under the auspices of the Committee, the Institute of British Carriage and Automobile Manufacturers has arranged to carry out practical trials with a number of selected Empire woods with a view to determining their suitability for motor-body building. Among the woods selected for the trials are Indian gurjun and sundri, samples of which have been requested from India by the Imperial Institute for use in the proposed experiments.

The Committee have also investigated the possibility of obtaining, from British sources, a satisfactory substitute for rock maple for the manufacture of boot-lasts. Among the timbers recommended by the Committee for this purpose is Indian haldu. As a result of enquiries made by the Committee, however, it appears that this wood,

although well suited for boot-lasts, is at present too expensive to compete with rock maple.

Raw Materials Committee

A number of Indian subjects have been considered by the Raw Materials Committee, which includes representatives of the principal Chambers of Commerce. These related to the trade prospects for Indian turpentine and rosin; Indian lac; essential oils; cotton stalks; kapok; as to which recommendations for action have been made.

IV. INDIAN SECTION—EXHIBITION GALLERIES

On the cessation of the occupation of the Exhibition Galleries by the War Office and other Departments, the work of redecoration, etc., and reinstatement of the exhibits was taken in hand, and is now completed.

A number of new exhibits have been added, including wood-carving, lac-ware, and silk fabrics from Baroda; a series of samples of salt illustrating the salt industry in Burma and Assam; a collection representing recent developments of native handicrafts in Burma; as well as samples of economic products, including timbers, raw silk, spices and indigo.

A number of exhibits relating to Indian materials examined in the Scientific and Technical Department of the Institute have been added to the collection, and others to illustrate the Reports of the Indian Trade Enquiry have been obtained from commercial firms.

No new exhibits have been received from the Government of India.

The statistical boards and diagrams shown in connection with the exhibits of products have been revised and new descriptive labels provided.

One of the most important requirements of the Section is the provision of modern show-cases. These were to have been provided by the Government of India, but the matter was postponed during the war. At present a number of the exhibits suffer from having still to be shown in antiquated cases, which compare very unfavourably with the excellent equipment which has

been recently provided in other sections of the Galleries, notably in the Ceylon, Egyptian, New Zealand, Canadian and South African Sections.

Besides the issue of various samples of Indian products to commercial enquirers, to lecturers, and to schools in connection with instruction in the commercial geography of India, samples have also been supplied for use by the various Committees of the Indian Trade Enquiry and by the Advisory Committees of the Institute on Timbers, Silk and Minerals.

In addition to the visitors to the Section who come for special information as to Indian products, there has been a steady increase in the attendance of schools and the general public. The public lectures and demonstrations on the exhibits of the various countries, including India, which were so successful before the war, have been resumed and more schools have applied for attendance than can at present be dealt with. A special lecture was given by Mr. Morris, Provincial Art Officer of Burma, on Burmese Village Industries, in illustration of the exhibits recently added to the Indian Section, and His Highness the Maharaja of Jhalawar held a largely attended Reception in the Indian Section, prior to his departure for India.

Visits to the Galleries, including the Indian Section, have been paid by Her Majesty the Queen, by H.R.H. Princess Mary, and by H.R.H. the Prince of Wales.

COTTON GROWING IN NIGERIA

In this Bulletin (1920, **18**, 448) it was announced that Sir Hector Duff, K.B.E., C.M.G., formerly Chief Secretary to the Government of Nyasaland, had been appointed by the Empire Cotton Growing Committee to undertake a mission in Nigeria for the purpose of collecting information as to the local conditions under which cotton growing is carried on in that country, and to report on the means by which the industry could most successfully be developed. Sir Hector Duff left this country for Nigeria on February 9, 1921, and returned on July 25, and the report on his five

and a half months' tour has been presented to the Committee, and has now been published.

The report, which is written in a most interesting manner, is divided into three sections, viz. (I) Descriptive, (II) Critical and Constructive, and (III) Miscellaneous. It contains as appendixes, a rough sketch map showing the route followed during the tour, statistics of the area and population of the various Provinces of Nigeria, and an excellent map of the country, prepared at Sir Hector Duff's request by the Survey Department at Kaduna from data supplied by the Northern Agricultural Department, showing in different shades of colour the primary and secondary cotton areas and also all the gazetted cotton markets and ginneries in the Northern Provinces. A brief summary of the principal features of the report and of the recommendations for the improvement and extension of the cotton-growing industry is given in the following pages.

In this connection, reference may be made to the article by Mr. P. H. Lamb on "The Present Position and Prospects of Cotton Growing in the Northern Provinces of Nigeria" published in this BULLETIN (1921, **19**, 469).

I. DESCRIPTIVE

In this section, a short description is given of the physical features of the country, its extent and population, the general character of the native inhabitants, the distribution of the cotton areas, the existing systems of communications, and the present constitution of the Agricultural Department, the Political Staff, and the Native Administration.

Attention is drawn to the great variation in the different Provinces in the density of population, which ranges from 363 per square mile in Onitsha to only 6 per square mile in Kontagora. A similar irregularity in the distribution of the population also occurs in different parts of one and the same Province; in Kano Province, for example, the population is concentrated in walled towns, whilst beyond the food radius of these crowded centres the average population diminishes very markedly. The natives are excellent cultivators, and their agricultural methods, which have been gradually evolved through the centuries, are

well adapted to the local conditions. Sir Hector Duff, therefore, suggests that modern methods and implements should not be introduced without careful consideration, and he points out that Mr. P. H. Lamb prefers the native system of tillage by hand to the use of the plough. He recommends, however, that modern methods and implements should be tried experimentally, and should be brought to the notice of the cultivators if they are proved to be suited to the local conditions, but that changes in the present system should not be brought about with undue haste.

The most active centres of cotton production in Nigeria are well served by the existing (Western) railway, which runs from Iddo (Lagos) to Kano (a distance of 705 miles), with branches from Minna to Baro on the Niger and from Zaria to Bukuru on the Bauchi plateau. A new (Eastern) line is under construction from Port Harcourt, and has already reached the Udi coalfield at Enugu, whence, after crossing the Benue near Abinsi, it will proceed north-north-west until it joins the main Western line at Kaduna.

Transport facilities are also afforded to some extent by the River Niger and its tributary, the Benue. The Niger is permanently navigable by steam up to Lokoja and, apparently, during the wet season, as far as Jebba, but above this point there are a number of formidable rapids. If it were possible to surmount this obstacle by blasting or canalisation, or if a railway were constructed from Jebba to Yelwa, the Niger might serve as a means of developing Northern Kontagora and South-Eastern Sokoto, which offer great possibilities for cotton cultivation. On both the middle Niger and the Benue, considerable merchandise is carried by canoes which shoot the rapids, but this mode of transport is unsuitable for cotton, as it is very slow, and necessitates frequent unloading of the cargo and its carriage over sand-banks and other obstacles. The cotton would thus be exposed to great risk of injury from damp and repeated handling.

Nigeria is well supplied with ordinary earth roads which have to be remade to some extent after each wet season. Such roads are cheaply constructed, and serve quite well for the Northern Provinces, where animal transport at present

forms the best and cheapest means of conveying produce to the railways. In the Southern Provinces, however, there are no draught animals, and the carriage of merchandise must become increasingly dependent on mechanical transport. Motor lorries are used in some of the southern cotton districts, such as Oyo, but the roads and bridges can only bear vehicles of moderate size and weight, and this, of course, increases the cost of transport. The pack animals of the Northern Provinces are chiefly camels and donkeys, but cattle are also used in some cases. A camel usually carries a load of about 400 lb., and a donkey one of 150 lb.

The Agricultural Department formerly consisted of two separate branches, for the Northern and Southern Provinces respectively, each with its own Director, but these have now been amalgamated under one Director, whilst Mr. Lamb, formerly Director for the Northern Provinces, has been appointed Deputy Director. It is hoped to strengthen the Agricultural Department by an increase of staff, but, unfortunately, this cannot be done at present, as it is necessary to limit expenditure as far as possible, owing to the fact that the revenue has suffered from the recent severe depression in trade. Reference is made to the success obtained by the Agricultural Department with American cotton (Allen's Long Staple), which has now been established throughout the Zaria Province and in many parts of the adjoining Provinces of Nassarawa, Nupe, Kano, and Sokoto, and it is pointed out that the credit for this must be shared with the British Cotton Growing Association and the Political Officers. The work of the experiment farms is also appreciatively mentioned, and stress is laid on the importance of substituting American cotton generally for the native varieties, and of eventually producing well acclimatised strains by selective breeding. It is considered that, in order to attain this end, the present agricultural establishment should be reinforced by the addition of a special cotton sub-department, including field-agriculturists and a first-rate scientific expert. Although great credit is due to the existing Agricultural Department, it is clear that it cannot provide the necessary European supervision or investigate the possibilities of

promising outlying areas of the country until an adequate staff has been provided. Important services can be rendered by the Political Officers of Nigeria, who, in virtue of the fact that they live among the people and possess their confidence, are able to encourage them to devote special efforts to the extension of cotton growing. Considerable assistance can also be given by the local Emirs, whose influence affords an ideal channel for reaching the native cultivators and conveying to them general instructions, advice and encouragement.

In concluding this section, Sir Hector Duff points out that Nigeria is a very promising region for cotton production, as it possesses enormous areas well suited to the crop, a sympathetic Government, intelligent native chiefs, a dense population, peaceable internal conditions, and seaports within a shorter distance of Liverpool than those of any other cotton-growing country in the British Empire.

II. Critical and Constructive

The first part of this section is devoted to a discussion of the mode by which the Agricultural Department of Nigeria should be strengthened when circumstances render this possible. It is considered that, apart from additions to the general staff, an adequate number of agriculturists should be appointed whose time and energies should be specially directed to cotton growing. It is hoped that it may be possible to provide ten or twelve such agriculturists, and the question of the means of finding suitable men for these posts is discussed. Provision should also be made for increasing the number of native cotton propagandists and instructors who should be trained and supervised by the European agriculturists. It is also suggested that the cotton staff so created should have its own superintendent, who, at any rate at first, should be under the immediate supervision of the Director of Agriculture. Such a cotton staff would consist only of field agriculturists, and would not be expected to undertake scientific research.

Scientific research, however, is regarded as of the highest importance, and should be placed in the hands of a first-rate scientific expert, whose special aim should be the evolution, by plant breeding and selection, of strains of

cotton thoroughly suited to the local conditions of different areas of the country, yielding a fibre of the character (as regards length, strength, colour, etc.) required by Lancashire spinners, and giving a large output and a high ginning percentage. When such strains have been bred and fixed, seed should be produced at specially established seed-farms and distributed to the natives. This would lead to the production of an improved cotton, which would not only raise the reputation of the Nigerian product in the market, but would also do much towards enabling it to bear the cost of auxiliary transport, *i.e.* the transport from the farm to the railway, even when low prices are ruling.

The question of auxiliary transport could be dealt with in two ways: (1) by attempting to obtain a reduction of the transport charges, and (2) by endeavouring to increase the intrinsic value of the cotton. While neither of these means should be neglected, the second is regarded as the more important. In this connection, reference is made to the cotton industry of the Oyo Province, which in 1921 produced 19,000 bales of lint, equivalent to about 24,000,000 lb. of seed-cotton, which was all grown from native plants, and was of rough, mixed quality, and worth only about 1*d.* per lb. Such cotton cannot be carried by motors or by native porters without loss, and could not have been transported during last season if the British Cotton Growing Association had not purchased it at more than three times its real value. As soon as the Association's guarantee expires, the question will arise as to the means of disposing of all this inferior material. Although it might be possible to reduce the cost of transport to some extent, this would not completely solve the problem, and it is therefore essential that the quality and value of the cotton should be improved. If a long-stapled American cotton, such as the Allen variety, could be substituted for the indigenous kind, and if from this, and perhaps from the native cotton also, strains were bred and established which would give lint of the highest quality and yield possibly obtainable under Nigerian conditions, the difficulty caused by the cost of transport would probably be overcome. Stress is therefore laid on the need for the appointment of

an expert of high scientific attainments to carry out such work.

The cost of employing such a staff as has been suggested above, and the conditions of their employment, are discussed.

Attention is next directed to the problem of transport. In considering the question of the railway extensions in Nigeria which would be of the greatest advantage to the cotton industry, it is pointed out that the Government will naturally be concerned, in the first instance, to complete the new line from Port Harcourt to Kaduna, which is known as the " Eastern Railway." It is suggested, however, that, during the course of this work, the possibilities of extensions should be investigated, the claims of different routes compared, and preliminary surveys carried out, so that further construction may be undertaken as soon as the present line is finished.

Whilst the cotton industry in the south-eastern corner of Sokoto Province, including the country in the neighbourhood of Chafe and between that district and Maska in South-Western Kano, would no doubt be benefited by a branch line from Zaria through Maska towards Chafe, it is considered that the existing railway runs sufficiently near to those points to render such an extension a matter of no immediate urgency. On the other hand, there are very promising areas in the west and south-west parts of the Sokoto Province and in parts of the Kontagora Province to the south of it, which need transport facilities to assist their development. It is therefore suggested that a line should be constructed which would link up Sokoto with the existing main railway at Jebba or Mokwa, or at some point between the latter place and Zungeru. Another extension which is recommended is a line from Maidugari in the Bornu Province, running south and south-west, possibly *via* Yola, and thence along the Benue Valley to some point on the Eastern railway now under construction. These lines would be much more direct and more serviceable than the extensions which have previously been suggested running west and east from Kano or Zaria to Sokoto and Maidugari respectively.

With reference to transport by water, a report by

Captain (now Major-General) Mance is quoted to the effect that it is hopeless to think of improving the navigation of the Niger between Jebba and Yelwa, where, as already stated, a number of rapids occur. If, however, a railway were constructed from Jebba to Sekachi (near Yelwa), shallow-draught steamers might be run from Sekachi on the Niger itself, and also on the Gulbin-Sokoto and Gulbin-Gindi. At the time of Captain Mance's report (ten years ago), cotton was largely grown in Kontagora and Southern Sokoto, and subsequently a cotton market was started at Yelwa by the British Cotton Growing Association but was abandoned later owing to lack of cheap transport.

The custom of transporting produce by means of native carriers is regarded as uneconomical, and it is stated " that no one of our possessions in tropical Africa . . . can ever attain its full development as long as, in any considerable part of it, the unit of transport is the negro's head."

The advisability is discussed of extending the use of motor transport in Nigeria, and making it the chief auxiliary means of conveyance. As already mentioned, the conditions in the Northern Provinces are very different from those obtaining in the Southern Provinces, and, in respect of the former area, the transport of ordinary merchandise by petrol-driven vehicles at so great a distance from the coast is impracticable at present on account of the prohibitive cost, and it must, therefore, continue to depend on the use of pack-animals. In the Southern Provinces, however, animal transport is not available, and cotton must, therefore, be conveyed from the farm to the railway either by native carriers or by motor transport. As native porterage is wasteful and unsatisfactory, the only alternative is mechanical transport, but in this connection it has to be borne in mind that the cost of carriage must not be greater than the industry can bear. Cotton has hitherto been carried by Government lorries at 1*s.* per ton-mile, but an increase of the rate to 1*s.* 6*d.* per ton-mile is now contemplated. As the cotton produced in the Southern Provinces is mostly of rather poor quality, and as the price of cotton is declining, it is feared that this increase in the cost of transport may have a serious effect on the industry. One of the factors which tend to increase the cost of motor

transport is the lack of macadamised roads, and the consequent restriction of traffic to light lorries which are relatively more expensive to run than larger vehicles. The difficulty arising from this transport problem is illustrated by the case of Okeni, in the district of Kabba, which is sixty-four miles south-west of Lokoja and thirty-five miles from Ajeokuta on the Niger. The cultivation of cotton in this area has been rapidly increasing, but the difficulty of procuring native carriers has now become so great that, according to the British Cotton Growing Association, either a motor road must be made from Okeni to Ajeokuta, or else the buying of Okeni cotton will have to be discontinued.

Brief reference is made to the roadrail tractor which, in the opinion of Brigadier-General Guggisberg, C.M.G., D.S.O., Governor of the Gold Coast, would do much towards solving the West African transport problem.

In the Northern Provinces, the existing native system of animal transport must be used wherever local conditions are suitable, but efforts should be made to improve it. This means of transport is so exclusively controlled by independent native owners that the position of those who, like the British Cotton Growing Association, have to depend on it for the conveyance of their produce to the ginneries and railways is somewhat precarious. It was, therefore, suggested by Sir Hector Duff that a supplementary animal transport might be organised and worked by the Government or the British Cotton Growing Association, but Mr. Percival (of the British Cotton Growing Association) has expressed the view that the natives would not readily lend themselves to any scheme calculated to divert the control of this transport to Europeans, and this opinion is shared by the Acting Lieutenant-Governor.

The breeding of the stock from which the Nigerian pack and draught animals are derived has been neglected by the natives, but this matter could doubtless be improved by a little skilled attention. It is considered that it would be better to develop the ordinary native stock by judicious selective breeding than to import pedigree stock.

One of the principal weaknesses of the Nigerian cotton industry is the lack of any adequate safeguard against adulteration and the mixing together of cotton of different

qualities. Adulteration is effected by adding sand, pebbles or pieces of rock, and sometimes the cotton is watered; these practices, however, while very objectionable, are of small importance in comparison with the absence of any attempt at grading. The British Cotton Growing Association is under agreement to pay the full guaranteed price for all cotton, however bad, so long as it is not absolutely unmarketable, and consequently low-grade cotton is purchased at exactly the same rate as the finest and best cotton produced in the country.

There is, therefore, no incentive to the native to attempt to improve the quality of his crop. The full guaranteed price is not generally obtained by the growers themselves, however, but by the middlemen, who in many cases buy the cotton at a very low figure, and then sell it to the British Cotton Growing Association at the fixed price, thus making a very large profit. Sir Hector Duff considers that this is not fair business and is inimical to the interests of the Nigerian cotton industry, and he recommends that some system should be introduced of roughly grading the cotton on the spot, so that a better price would be paid for cotton which has been carefully grown, picked at the proper time, and kept clean, than for cotton which has been wilfully neglected or even adulterated. On the other hand, it is suggested that it would be neither fair nor expedient to make a difference in the prices paid for native cotton on the ground of quality in cases where the deviation in quality is due solely to natural causes (such as conditions of soil and climate) and not to lack of care on the part of the cultivator.

Whilst recognising that the extension of the cotton industry in outlying districts is of great importance, it is recommended that attention should be particularly directed to the development of the railway belt, *i.e.* the area within fifteen miles of the railway on each side of the line between Ibadan and Kano, a distance of about 600 miles. Every effort should be made to ensure that all the land in this belt which is adapted for cotton and can be spared from the cultivation of foodstuffs should be planted as soon as possible. There are large areas which are reported to possess a soil eminently suitable for cotton growing at

numerous points on the railway, such as those between Kaduna, Zungeru and Minna, which hitherto have hardly been touched. In some cases, this is said to be due to scarcity of population, and in others to the deficiency of agricultural officers. In the former case, the Government should be asked to assist in attracting settlers to such areas, whilst in the latter case it is hoped that a remedy will be found by some scheme for increasing the staff of the Agricultural Department, such as is suggested in the first section of the *Report* (see page 49).

With regard to the development of the cotton industry in outlying regions, it is essential that, in addition to a fertile soil, there should be a sufficient labour supply and efficient means of transport. There are many parts of Nigeria which are said to be good cotton tracts, but these, obviously, cannot be developed until markets are available, and markets will not arise until means of transport are provided. Transport facilities, however, cannot be arranged until there is something more than mere reputation to warrant them. It is suggested therefore that an area which is reputed to possess favourable conditions should, in the first instance, be visited by a cotton agriculturist, who should test the possibilities as thoroughly as possible, should endeavour in conjunction with the Political Officer to arouse the interest of the natives, and should study the question of rival crops and other agricultural factors likely to affect the development of a cotton-growing industry. If the report of this agriculturist should be favourable, the Government should be requested to provide transport facilities. It is recommended that the preliminary work should be undertaken at an early date, since the cultivation of cotton in established centres, such as Zaria, is gradually approaching the limit to which it can extend without encroaching on the area required for the growth of necessary food crops.

In connection with the question of guaranteed prices, the policy of the British Cotton Growing Association of fixing a definite price for seed-cotton from year to year has encouraged cultivation and helped to stabilise the industry. It is recommended that this practice should be continued, and that the price guaranteed should be as

liberal as possible. A suggestion which has been made by certain Colonial Administrations, that the price should be fixed for a term of years instead of for a single season, is regarded as impracticable owing to the great fluctuations of cotton in the world's markets, and it is mentioned that, even under the system of an annual guarantee, the British Cotton Growing Association made a heavy loss last year. Moreover, as cotton is an annual crop, the native, on sowing his seed, commits himself for one year only, and it is therefore unnecessary to guarantee the price for more than one season at a time.

The institution of native Agricultural Shows is recommended, as it is considered that the award of fairly substantial prizes for the best samples of cotton in different classes might possibly have a good effect.

A suggestion made to Sir Hector Duff, before leaving this country for Nigeria, that it might be worth while to consider the possibility of some system of insurance to protect the growers from losses arising from the failure of the crop owing to adverse climatic conditions or similar causes, was duly considered, but it was concluded that no such arrangement would be feasible as, owing to the scattered nature of the cultivation and the large number of individual growers involved, the claims could not be properly adjudicated.

Nigeria is not well supplied with trading stores where the natives can spend the money which they obtain by the sale of their produce. In most outlying cotton areas there do not seem to be any such stores, and it is considered that it would be of advantage for temporary stores to be opened close to every cotton market during the buying season. They should be stocked with a varied selection of the goods most in demand, and should be in charge of native agents under the control of local European firms. This would have the effect of stimulating the native cultivators to earn money, would benefit British trade, especially in manufactured cotton goods, and would increase the Nigerian revenue.

The comparative advantages of the two possible methods of disposition of the ginneries, viz. (1) along the permanent transport routes, and (2) in the actual centres of

cultivation, are discussed, and it is observed that the former system is adopted by the British Cotton Growing Association and is upheld as the better method by other authorities.

The system of land tenure in Nigeria differs from that of the East Africa Protectorates in the absence of large European freehold estates. The natives of Nigeria are independent cultivators, who grow their crops on their own account and not for a fixed wage, and dispose of them as they like. It is considered that, if the natives are adequately guided, instructed and encouraged, this system can effect the development of a country more thoroughly, rapidly and economically than would be possible in any other way, and this view is supported by the fact that it is in those countries in which independent cultivation prevails that the cotton industry has been most successfully extended.

Only a small proportion of the growers take their cotton to the ginneries, where alone they can obtain the full price for it, most of them preferring to sell it to middlemen, either at their own farms or at one of the outlying markets. Although official feeling is decidedly opposed to the middlemen, owing to their tendency to take unfair advantage of the natives, it must nevertheless be recognised that they serve a useful purpose, as without their aid much of the cotton now exported from Nigeria would never be grown. Until the railways are so extended as to bring the outlying cotton districts into direct touch with the ginneries of the British Cotton Growing Association, the middlemen will continue to be necessary as a connecting link.

It is not thought that cotton has much to fear from the competition of rival crops, and in this connection it is pointed out that the oil-palm belt and the areas suitable for cocoa do not overlap the cotton belt to any great extent. Ground nuts can be grown on much of the land which is suitable for cotton, but the actual soil requirements of the two crops are by no means identical. It is, therefore, inferred that it is possible for cotton to be cultivated on a large scale in Nigeria without any danger of its incurring a pronounced economic struggle with other crops.

The influence of the indigenous spinning and weaving industry on the cultivation of cotton for export is discussed. Although this manufacturing industry creates a local demand for raw material which would otherwise be available for export, it has undoubtedly been of great advantage in the development of cotton production, as in virtue of its requirements the natives have long been familiar with the cultivation of the crop. It is considered that the native manufacture of cotton goods is now beginning to decline, and will do so more rapidly when Lancashire cloth of fairly good quality is imported into Nigeria at consistently moderate prices.

There are certain areas in Nigeria—especially in Kontagora Province—which are very suitable for cotton growing, but are incapable of immediate development owing to the sparseness of the population. It is suggested that efforts should be made to populate these districts by encouraging immigration from more closely settled regions, if this could be done without prejudice to existing political and other interests.

III. Miscellaneous

In this concluding section of the Report, Sir Hector Duff pays tribute to the work of the British Cotton Growing Association, and also refers to the desirability of arousing the Political Officers to a sense of the great importance of the cotton industry, not only to Nigeria, but to the whole Empire.

It was stated by Mr. A. H. Kirby, Acting Director of Agriculture for the Southern Provinces, in his official report for the half-year ended December 31, 1920, that the price for seed-cotton (3½*d.* per lb.) which was guaranteed by the British Cotton Growing Association had resulted in the native growers being paid for their lint at a rate equivalent to 1*s.* 2*d.* per lb., at a time when the market value was only 6½*d.* per lb. at the port of shipment. This policy was continued during 1921, with further heavy losses to the Association, but with corresponding gains to the native farmers, the middlemen, the European trading firms and others, and it is generally admitted that, in 1921, the cotton industry did much to save the Nigerian trade situation.

Although the Political Officers have done a good deal to assist the cotton industry, it appeared to Sir Hector Duff that few of them realised its importance from an Imperial standpoint, its typically British character, and the dangers which threaten it. It is, therefore, suggested that an endeavour should be made to awaken the interest and enlist the sympathy of these officers, and that for this purpose a short, clear statement of the Imperial aspects of the industry would be of considerable value.

Supplementary Note

Since the issue of this *Report*, the Empire Cotton Growing Corporation have published a "Supplementary Note by Sir Hector Duff on Light Railways."

As an example of the advantages to be derived from the use of light branch lines, reference is made to the Bauchi light railway (2 ft. 6 in. gauge) which runs from the main line at Zaria to Bauchi, a distance of about 150 miles. This railway, although constructed primarily in the interests of the tin mines, has effected a marked development of the cotton industry in the area it traverses. This line belongs, of course, to the northern railway system, but it is suggested that experiments should be made in the south, preferably in Oyo and in the Kabba district of Ilorin. In the first instance, a light railway might be built from Ibadan through Oyo to Isseyin (about 30 miles). This line could be much more cheaply constructed and more cheaply worked than a mountain railway, such as the Bauchi line. Moreover, it need not be so powerful or so elaborate as the latter, since for subsidiary cotton transport a purely "feeder" track of the cheapest and lightest kind—a line perhaps of the nature of a tramway with a gauge of about 2 ft.—would suffice.

It has been contended that light railways are objectionable, as they involve considerable delay in breaking bulk and transferring cargo. It is considered, however, that the disadvantages of the extra handling of goods which must occur in moving them from a light line to a heavier one are more than counterbalanced by the great benefits which light railways confer.

Reference is also made by Sir Hector Duff to the

roadrail tractor (see page 54), and it is stated that this system is now being tried by the Governments of Kenya Colony and the Uganda Protectorate and that the results of these trials will be of great interest in connection with the problem of auxiliary transport in Nigeria.

THE GRAPHITE INDUSTRY OF MADAGASCAR

THE following account of the Madagascar graphite industry has been prepared by Mr. A. D. Lumb, A.R.S.M., M.Inst.M.M., F.G.S., from information available at the Imperial Institute.

The production of natural graphite in Madagascar began in 1907 with an output of 8 metric tons, obtained in the province of Antananarivo. In 1909 prospecting was seriously undertaken over wide areas, both inland and along the east coast of the island in the districts of Antananarivo, Vatomandry, Andevorante and others. The prospectors were well rewarded for their efforts, and deposits of graphite were found mainly along a line running nearly the whole length of the island from Cape Amber in the north as far as Fort Dauphin in the south. Rapid development and exploitation followed these discoveries, and the output continued to increase at a great rate in succeeding years. The highest production was reached in 1917 with 35,000 metric tons, which exceeded the Ceylon output.

Since 1917 production has fallen as rapidly as it rose, the principal reasons being that in 1918 France placed an embargo on the shipment of graphite from Madagascar to France, and London at the same time cancelled purchase contracts for a total of 28,000 metric tons. Efforts were made to dispose of the Madagascar graphite in the United States, but that country had temporarily ceased to buy graphite.

During the war graphite was in considerable demand for the manufacture of crucibles used in the making of crucible steel and various alloys needed for munitions,

and the bulk of the crystalline graphite produced in recent years has been utilised for this purpose. After the war large stocks of crucibles and graphite were left on hand at the factories, and producers also found themselves with large surplus stocks, which they were unable to dispose of. The demand for graphite has been further decreased owing to the present tendency to substitute electric-furnace steel for crucible steel. Lack of shipping facilities at the end of the war helped to complete the depression of the industry. On the removal of import restrictions by the United States War Trade Board in January 1919, there was an open market for Madagascar graphite, but none was purchased by the United States until December of that year, and then only 1,364 tons, of which 340 were obtained direct and 1,024 tons *via* France. In April 1920 the Chief of Mines, Madagascar, reported that there were then 32,000 tons of graphite in stock in the island. At the end of 1920 there were still 25,000 tons reported to be on hand, although most of the mines had ceased production.

The following are the official figures of the production and exportation of Madagascar graphite since the industry started.

Production and Exports of Madagascar Graphite [1]

(Metric Tons)

Year.	Production.	Exports.	Year.	Production.	Exports.
1907	8	8	1914	11,232	7,940
1908	82	109	1915	15,940	12,189
1909	197	200	1916	26,254	26,209
1910	545	554	1917	35,000	27,838
1911	1,247	1,281	1918	16,000	15,015
1912	5,318	2,638	1919	5,000	4,050
1913	7,227	6,573	1920	4,500	14,919

[1] *Mineral Industry*, 1920.

Of the 14,919 tons shipped in 1920, 4,449 tons went to England, 2,127 tons to the United States, 50 tons to Belgium, and the balance to France.

For the sake of comparison the recent annual production of graphite in other countries is shown in the following table :

World's Production of Graphite [1]

(Metric Tons)

	Austria.	Bavaria.	Canada.	Ceylon.	India.	Italy.	Japan.	Mexico.	Sweden.	United States.[2]
1911	41,599	11,298	1,154	27,433	4,047	12,621	114	2,974	65	3,280
1912	45,375	12,532	1,873	33,106	Nil	13,170	149	2,865	79	3,318
1913	49,456	12,032	1,961	29,277	Nil	11,145	665	1,057	88	4,331
1914	—	13,600	1,494	14,451	Nil	8,567	574	3,864	56	3,935
1915	—	16,900	2,368	22,159	71	6,176	666	1,524	87	4,280
1916	—	30,600	3,589	33,947	1,341	8,182	1,144	4,836	194	7,339
1917	—	37,500	3,369	27,482	105	12,117	1,329	6,868	123	12,331
1918	—	—	2,768	15,702	82	11,653	1,811[3]	6,191	—	11,785
1919	—	—	1,234	6,778	129	7,626	—	4,023	—	6,733
1920	—	—	2,020	—	—	4,190	—	2,992	—	8,627

[1] *Mineral Industry*, 1920.
[2] *Exclusive of artificial graphite.*
[3] *Mineral Resources* 1919, *U.S. Geol. Survey.*

Native graphite is found in two forms, crystalline and amorphous. The crystalline variety is in the form of crystals large enough to be visible to the naked eye. In Ceylon it occurs in veins, and is known as vein graphite, but elsewhere, as in Madagascar, it is found as flakes disseminated through the country rock, when it is known as flake graphite. Crystalline graphite is generally associated with granite intrusives. The amorphous form of graphite has the appearance of a black powder.

The graphite in Madagascar is almost entirely of the flake variety, and occurs in schists and gneisses in the older crystalline rocks, which extend over two-thirds of the island. The deposits are confined, so far as is known, to the eastern side of the island, as is shown on the accompanying map. There are two producing tracts of country, a plateau region in the interior and a lowland region near the coast. In the former, graphite is generally found in graphitic schist, but sometimes as irregular pockets in vein formation. In the coastal area graphite is obtained from decomposed surface material, derived from gneiss, which being non-coherent is easily excavated. In the gneiss it occurs usually in the form of disseminations, replacing mica. The deposits are most irregular in shape, and frequently show marked changes in thickness over a small lateral distance. Quartz may often be seen in them in lenticular masses, and there may be a network of small

veins of white felspar through the graphite. One of the characteristics of the deposits is that running parallel with them, and in close proximity, is an unmistakable outcrop of quartz. Graphite often extends beyond the quartz intercalations, but its relation to the quartz is beyond dispute.

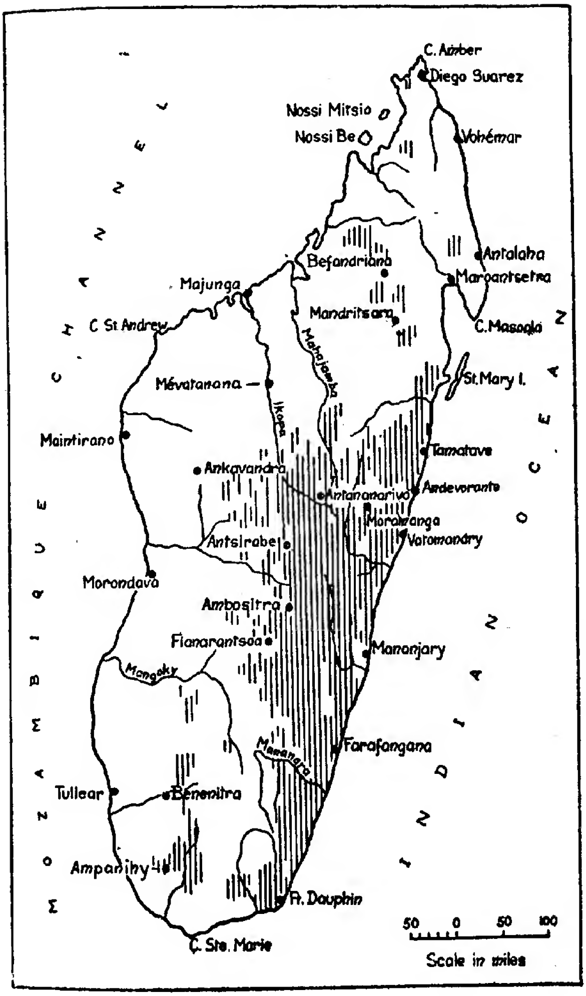
Both flaky and amorphous graphite are often met with in the same deposit in Madagascar, especially on the plateau ; in the same lens a flake variety may pass rapidly to an amorphous one ; nevertheless the flake material predominates, and when present the deposit has a schistose appearance, a number of veinlets being separated by barren intercalations of quartz. The richest graphite is not obtained on the surface, as there it is mixed with a certain amount of clayey and sandy matter, deposited by percolating water. The deposits, particularly where they occur in the decomposed rock, are of shallow depth and are easily and cheaply worked by open quarrying. In this respect Madagascar possesses an advantage over other producing countries. Ceylon can supply graphite more favoured for the manufacture of crucibles on account of its crystalline structure and greater purity, containing less mica and pyrite than that of Madagascar ; but owing to the expense incidental to deep mining, working costs are appreciably higher. Up to ten years ago Ceylon enjoyed almost a monopoly, but that position has since been largely modified by the production of other countries, especially Madagascar.

Madagascar graphite is of excellent quality, about 60 per cent. of the production being considered of crucible grade. Very large supplies are available and the output could be much increased if necessary.

The plateau region received most attention at first, because the initial discoveries were made there, and because there was labour available on the spot ; but shortly afterwards attention was transferred to the east coast, and to the neighbourhood of the railway. On the plateau the productive regions are in the provinces of Antananarivo, Antsirabe, Ambositra, and Fianarantsoa ; near the coast they are in the provinces of Tamatave, Moramanga, Vatomandry, and Farafangana. The dis-

SKETCH MAP OF MADAGASCAR.

(Graphite-bearing areas shaded.)



tribution of graphite-bearing areas in Madagascar is indicated in the accompanying map, which has been adapted from one appearing in *Bulletin Économique de Madagascar*, 1919.

The Chief of Mines at the end of 1918 estimated the reserves to be 10,000,000 cubic metres of marketable graphite, ignoring mineral below a depth of 100 metres. The disseminated deposits may show contents as high as 60 per cent. of graphite. The average amount of flake mineral in normal deposits is 20 to 30 per cent., but a deposit with only 10 per cent. is considered workable.

The mines are worked entirely by natives, with European supervision for the larger enterprises. The industry has suffered much from scarcity of labour, particularly on the coast, and for that reason higher wages are paid there than on the plateau ; the cost of living is also greater on the coast. This shortage of labour could best be met by the introduction of more up-to-date mechanical methods. Transport is in some cases a difficulty, the graphite from some of the mines having to be carried for considerable distances on men's backs.

The separation of the pure graphite from the gangue is a rather difficult matter, principally owing to the presence of mica, which is of nearly the same specific gravity as graphite, and occurs in the same flaky form. The graphite obtained from decomposed rock is dressed with less difficulty, because the alkaline and calcareous elements contained in the felspars have been dissolved and carried away by circulating waters.

In the early stages of the industry the method of treatment was very primitive, the process consisting in washing the material in a wooden trough, drying in the sun, vanning, and sifting in a hand-sieve. This method is still used for about 5 per cent. of the total output. After a few years mechanical methods were in most cases substituted for this primitive treatment. Recent and up-to-date practice, which is stated to furnish about 20 per cent. of the present output, makes use either of a dry method, or a wet method, or a combination of the two, and a final concentration by oil flotation. This last treatment ensures a satisfactory separation of the mica and silica from the refined product.

Before the war the graphite market was in the hands of a few large firms. As with other materials, prices generally respond to the economic laws of supply and demand. In the case of graphite they are to a certain extent dependent on the size of the flakes and the percentage of contained carbon. In 1913–18 prices ranged from 400 to 800 francs per ton f.o.b. native port for material with 90 per cent. of carbon. Prices in 1920 averaged 600–700 francs per ton f.o.b. Tamatave or Vatomandry, for material with 85–90 per cent. of carbon. Freight to France was quoted at 200 francs, and to London, New York or Hamburg at £7 per ton. It is stated that Madagascar " flake " can be produced profitably at a cost low enough to allow of a selling price of 500 francs per ton f.o.b.

Since the armistice Great Britain and France have bought largely from Madagascar, supplies also coming into the former country from Korea, Mexico and Spain. The low value of the French franc and the high value of the rupee unfavourably influenced the Ceylon industry. The other principal graphite-purchasing countries are the United States, Holland, Italy, Belgium and Sweden. Russia has insufficient domestic supplies, but since the war no graphite has been imported into the country. Until the deposits on the Murman coast and Siberia are fully explored and developed Russia must largely rely on foreign sources of supply. Other countries requiring graphite are China and Japan.

The Madagascar and Ceylon deposits are the most important in the world, and are likely to be so for some time to come.

It has been mentioned above that the deposits of Madagascar are of great extent, and can be mined cheaply near the surface. A large proportion of the graphite is of crucible grade, and the product has been introduced into all consuming countries, in some of which a preference for Madagascar graphite has been created. There are great reserves of the mineral, and the " Union des Producteurs de Graphite " of Madagascar is in a position to guarantee large deliveries of material containing 85 per cent. of carbon.

In Ceylon, on the other hand, although the product is

highly esteemed for crucible purposes, mining is expensive owing to the mineral occurring in veins at some depth, and the product at present cannot be sold at prices to compete with Madagascar graphite. It seems necessary, in order that Ceylon may maintain its position in the graphite industry, that more modern and co-operative methods of mining and dressing should be introduced, and that operations should be carried out on a larger scale to reduce the cost of production.

References to Principal Literature :

1. *Bulletin Économique, Madagascar*, 1919.
2. *The Mineral Industry*, 1920.
3. *Graphite*, by H. S. Spence (*Canada Dept. of Mines*, 1920).
4. *Graphite*, by H. G. Ferguson (*Min. Res. of U.S.*, 1918, Part II).
5. *U.S. Comm. Rept.*, No. 90, 19 April, 1921.
6. *Foreign Graphite*, by A. R. Redfield (*Min. Res. of U.S.*, 1919, Part II).

NOTES

The Imperial Institute and the War Museum.—A Special Meeting of the Executive Council of the Imperial Institute was held on Wednesday, February 22, at which Lord Islington presided, and the following members were also present : Viscount Burnham, C.H., the Right Hon. Sir Joseph Cook, G.C.M.G. (High Commissioner for Australia), the Hon. Sir James Allen, K.C.B. (High Commissioner for New Zealand), the Hon. Sir Edgar Walton, K.C.M.G. (High Commissioner for South Africa), Sir Robert Kindersley, G.B.E., Sir Robert Carlyle, K.C.S.I., Sir Richard Threlfall, K.B.E., Mr. D. O. Malcolm, and Professor Wyndham Dunstan, C.M.G., F.R.S. (Director of the Imperial Institute).

The following representatives of Advisory Committees were also present : Viscount Harcourt (Mineral Resources Committee), Sir Harvey Adamson, K.C.S.I. (Committee for India), Sir Keith Price (Committee for Canada), Sir Frank Warner, K.B.E. (Silk Production Committee), Mr. A. M. Samuel, M.P. (Raw Materials Committee) and Mr. James Richardson (Timbers Committee).

In amplification of the papers which had been circulated to the Council, Lord Islington explained the proposal of the Office of Works for appropriating about one-half of the Exhibition Galleries of the Imperial Institute in order to house the exhibits of the War Museum now at the Crystal Palace, and the reasons advanced in support of this proposal.

After full discussion the following Resolution was adopted:

> "The Executive Council have fully considered the proposal made by the Office of Works that a large part of the Exhibition Galleries of the Imperial Institute, now containing exhibits illustrating the present position and resources of the Dominions and Colonies, should in future be occupied by exhibits of the War Museum to be removed from the Crystal Palace.
>
> "The Council regard the proposal as neither practicable nor expedient, and representations to the same effect have been made to the Council by the Technical Advisory Committees of the Imperial Institute; by the principal Chambers of Commerce, and by numerous other public bodies associated with the promotion of the operations of the Imperial Institute.
>
> "The Council are clear that the Empire Collections now shown at the Imperial Institute could not be concentrated in the Galleries to the extent suggested, without impairing their efficiency and rendering any development in the future impossible. The Council are convinced that these Collections are serving, and will, in future, increasingly serve, important educational and commercial objects, and that these Collections should be further improved and extended. To impair seriously the space for these Collections as proposed would not only be most prejudicial on general grounds, but would also jeopardise the continuance of those contributions from the Dominions and Colonies on which the income of the Institute so largely depends.
>
> "The Council are therefore unable to assent to the proposal to occupy a large portion of the Galleries for an object which is foreign to the purposes for which the Imperial Institute was erected and endowed.
>
> "The Council fully appreciate the desire for economy in housing the War Museum, but consider that this should be achieved otherwise than by sacrificing the interests of the Imperial Institute."

The following leading article on the proposal to transfer the War Museum to the Imperial Institute appeared in *The Times* of March 7, 1922:

"The Executive Council of the Imperial Institute has passed a formal resolution objecting to the proposal that a large part of its space should be withdrawn from its present use and be given over to exhibits from the War Museum now at the Crystal Palace. The Council thinks that this would not only involve an impracticable and undesirable restriction of space, but would be seriously detrimental to the general interests of the Institute, as well as to the development and expansion of the educational and commercial work for which it was erected and endowed. In our opinion, the objection is well founded and rests on more solid grounds than the mere dislike of interference which every settled establishment feels. A Special Correspondent, who is connected with neither institution and has visited both, gives this morning a reasoned examination of the proposal from the point of view of the public interest. He describes the practical and growing work, which is both economic and educational, done by the Institute, and expresses the opinion that it would be seriously checked and injured by squeezing the contents of half the galleries into the remaining half and so crowding them all up together. If that is so, the project ought not to be entertained; for the Institute is performing functions of great value now, but of still greater value for the future, and they should on no account be hampered or checked. That overcrowding would have this effect we know from experience of collections; and unless half the space is unoccupied there would necessarily be overcrowding. But so far from being unoccupied, it appears that the space is already insufficient for the increasing requirements. It must be remembered that half the building is given up for the present to London University, and that the work of the Institute is by its nature expanding work, to which no limit can be assigned. It is systematically planned on the principle of giving each Dominion or Colony a section to itself. That would obviously be destroyed by distributing Canada, for instance, over half a dozen other sections and mixing up Newfoundland with West Africa, which is the sort of expedient that would have to be adopted. Some of the sections are only now in process of completion, and none is final; the interest in them is a growing interest, full of future promise. The War Museum, on the other hand, is entirely concerned with the past, and popular interest in it is now faint. If it ever revives, it

will be a long time hence and will be only an interest of curiosity. The emotion which led to its formation seems to be exhausted by its own intensity ; it is burnt out. Those who have collected and arranged the War Museum naturally regard it with parental fondness ; but whatever may be its future, its preservation does not justify such sacrifice of living interests as would be involved in the present proposal."

The following is an article by a special correspondent of *The Times* which appeared in the same issue :

" There is something mysterious about the way the project to transfer the War Museum to the Imperial Institute is being pushed ; for no unbiassed person who takes the trouble to examine both institutions can possibly endorse it.

" It has been stated that the Geddes Committee have recommended the transference. On the contrary, the Committee, after mentioning the proposal in perfectly colourless terms, expressly declined to make any recommendation.

" The objections to the proposed transference are twofold—it would seriously diminish the efficacy of the Institute, curtail its existing operations, and put a stop to development, and at the same time it would not preserve the War Museum.

" The work of the Institute was described in *The Times* of January 16. It serves a double function—(1) economic ; and (2) educational—and both are continually increasing in importance. The economic function is the original purpose for which it was founded and built out of public subscriptions, and for many years now that purpose has been systematically pursued under scientific direction. The plan has been to collect, organise, display, and investigate the natural resources of the Empire. There is no other such collection anywhere, though other countries are beginning to organise imitations. Here are the products of the Dominions, Crown Colonies, and Protectorates, displayed in orderly sequence and in all their wonderful profusion and variety, explained, illustrated and described. Take, for instance, the Canadian gallery. You begin with the minerals, in which Canada is extraordinarily rich ; they are shown in the natural and the applied state, with information on the yield, locality, uses, and so on. Then follow agriculture, forestry, fisheries, and wild animals,

treated in the same way and illustrated by photographs. You are shown the grains, fruits, timbers, animal products, their qualities and uses. One after another all the countries are treated in the same systematic way. And detailed information is available about all of them. The place is a mine of commercial and scientific knowledge. The development and utilisation of the resources are promoted; new products are brought for comparison and scientific examination. The contributory countries themselves and the tending corporations at home are continually growing more alive to the value of the Institute as its work becomes more complete. Its educational value is equally great, and also constantly gaining in appreciation. Guide lecturers go round with parties, and schools come in increasing number for lessons in geography, in the origin, nature and uses of the natural products collected from all parts of the world.

"The present proposal is to annex half the galleries, clear out the objects described, cram them into the remaining half, and substitute for them the relics of the war that form the War Museum. There is not room to do it. The telescoping of half the galleries into the other half would convert the whole into a lumber room by overcrowding. It would be fatal to the educational uses of the Institute. If the object of those who favour it is to preserve the collection that forms the museum then the scheme is quite inadequate. There is not room for the museum, which includes a mass of bulky articles. Where are the aeroplanes, the model of the 18-in. naval gun, the observation periscopes that reach to the roof of the Palace, to go?

"There are many other huge things—guns of every kind in vast numbers, and enormous carriages, German tank trophies, parts of airships, special equipments with wooden horses and things of that kind. It cannot be intended to transfer all these to the Imperial Institute. The galleries are quite unsuited to display them, even if they could be got in. Some must be left out, which means breaking up the collection as an integral whole. Its *raison d'être* would then be gone, for it is intended to be a memorial of the war, as complete as possible, and, although it is far from complete (even the Palace cannot accommodate airships and Dreadnoughts), great pains have evidently been taken to make it so. It is a multifarious collection, and includes much that has no other claim to preservation than connection with the war. If it is to be preserved as a whole some derelict war factory would be the most appropriate place. If not the contents should be classified

and distributed among various galleries according to their character."

The following leading article on the proposal appeared in *Nature* of April 1, 1922:

" It is astonishing that, at a time when the Imperial Institute is looking forward to further developments in its work, a proposal should be put forward involving the dismantling of more than half of the recently extended and improved collections in the Public Exhibition Galleries of the Institute—without question the finest illustration of economic geography in the world—in order to make room for the war relics known as the Imperial War Museum at present housed in the Crystal Palace. *The Times* of March 7 contains leading and special articles on the subject in which a clear case is made for the abandonment of the proposal. Attention is directed to the resolution of protest recently passed by the Executive Council of the Institute. While appreciating the desire for economy in housing the War Museum, the Council considers that this object should be achieved by some other method than by a plan which would be seriously detrimental to the development of the educational and commercial work for which the Imperial Institute was erected and endowed. Resolutions of protest have also been received by the Council from a number of important bodies, including the Association of British Chambers of Commerce; the Chambers of Commerce of Liverpool, Manchester, Glasgow and Bristol; the Royal Institute of British Architects; the Timber Trade Federation; the Institute of Builders; and the Silk Association.

" For a quarter of a century the Imperial Institute, with very slender means, has been carrying on work of great service to the Empire, a fact far too little known and appreciated. The reward of such endeavour should be the provision of better facilities for development, and it is precisely in this respect that the proposals now put forward on behalf of the War Museum would be so detrimental in their effects. The Imperial Institute is becoming the recognised headquarters of organised effort in this country for the development of knowledge of the natural resources of the overseas countries of the Empire, and it is to be hoped that the Government will see that nothing of the character of the proposals justly condemned by *The Times* shall prevent the achievement of so desirable a purpose."

The Work of the Imperial Institute for the Empire.—The following articles, written by a special correspondent of *The Times*, are reprinted from *The Times* of December 2, 1921, and January 16, 1922:

Empire Trade Pioneers

"The hat-makers of Luton, wishing to get new sources of material for their manufactures, recently sought the help of the Imperial Institute. The Institute obtained specimens of specially made plait from various British Colonies. Novelty was one detail to be borne in mind; economy was another, since Japan and China produce very cheap plait. Among other Colonies, from the Seychelles came both plait and hats made from it. Luton praised the craft shown in both, and sent out a trial order. The result of the experiment remains to be seen.

"This single example, chosen from many, will give some initial idea of the work done in that great building in South Kensington which was founded as a memorial of Queen Victoria's Jubilee. It has passed through several phases. At one time it formed a first-rate club, at once cheap and luxurious, for those of the public who had, or were supposed to have, a peculiar interest in the Empire. But this brought a burden of debt, and was followed by the adoption of the Institute by the Government and its management by a representative executive council under the control of the Colonial Secretary. Since the war appeals have been made by Lord Milner to the Governments of the Dominions and Colonies, as well as to the Home Government, to place the finances on a satisfactory basis. The satisfactory basis ought to be easily reached, for the Institute carries on a big and profitable Imperial work on an income of about £30,000.

"How it is done is a problem which assails the visitor at every step he takes through the principal departments. These relate to Investigation, Intelligence, and Exhibition. With the last I shall not deal now; the galleries are another story, and, for the present, the other two branches are sufficiently exacting in their scope.

"Investigation, as the Imperial Institute understands the word, means the scientific exploration of the qualities and commercial possibilities of any product of any Dominion or Colony. In some corner of the Empire a man thinks he has come on a good thing. He may write direct or seek advice from the nearest Government office. If the good thing is not chimerical on the face of it, a specimen accompanied by an inquiry is addressed to South Kensington. The chemists or the mineralogists employed there

set to work on it. They analyse; they disintegrate; they even experimentally manufacture; they also consult both merchant and manufacturer; and in due course a reply is sent to the effect that the good thing is good for this, that, or the other purpose which, in the British market, is worth so much at the moment. It then rests with the people over the water to decide whether the report, in its particularity, justifies them in shipping a raw material or manufacturing for home consumption alone or also for export. They have the facts; and on the facts, supplied by the Imperial Institute, new industries have been prosperously set going.

"In a large room furnished with glazed cupboards and cabinets the Institute preserves many material records of its successes in this branch of its work. They form a remarkable demonstration of the almost romantic interest that lies in science strictly applied to the cause of commerce. Here are, for instance, pieces of timber from New Zealand, bamboo from East Africa, elephant grass from Uganda, and other grasses from West and South Africa. They are relics and results of experiments in paper-making. New Zealand—to indicate the history of one of them—has a good deal of waste wood, which, the Institute suggested, might be turned into paper-pulp or employed in distillation. Experiments on a small scale were made with the samples sent from New Zealand, and a report was made to the New Zealand Government, stating that the yield of pulp and paper was quite promising, and pointing out the different factors to be considered before the manufacture could be taken up commercially. Into these points the Forestry Department in the Dominion is now looking; and meanwhile the paper made in the laboratories can be examined in the Institute's very modern museum.

"A similar course was pursued with the acacia pods from the Sudan, also to be seen here, and these pods are now sold as a tanning material in London. Other problems either solved or in process of solution are the utilisation of cotton-stalks, the best method of improving the tobacco of Nyasaland, South Africa, and elsewhere, and African wild silk. The last offers some fascinating exhibits, whether one regards the busy insect or the stuff which is the ultimate outcome of its endeavours.

"The laboratories, when I saw them the other day, were engaged in special research relating to the causes of variation in the properties of plantation rubber, in which the Colony of Ceylon is co-operating. So thorough is the investigation that the rubber sent from Ceylon is vulcanised and mechanically tested. Another piece of laboratory

work is the examination of a certain exudation from a tree in the Solomon Islands. On distillation it has been found to yield a volatile oil, which forms a substitute for oil of aniseed, while the residuum is a hard resin useful for varnish making. In the mineralogical branch you are shown what is being done with regard to clay, cement, and pottery, the questions to be answered concerning the wisest employment of the clay and the emendation of the pottery. Another profitable inquiry had to do with Ceylon monazite sand, which enters into the making of gas mantles, formerly a German monopoly. A considerable export trade has now been started from Ceylon.

"The Technical Information Bureau would alone more than justify the claims of the Imperial Institute to still wider powers and better endowment. A small staff collects and arranges such technical and commercial knowledge and particulars as are likely to be needed by inquirers. Its sphere includes botany, chemistry, and commerce; and when it receives a letter or caller requiring information it cannot supply from the stored funds of the Department, it passes on the question to one or other of the specialist members of the Institute staff, or to one or other of the technical committees which meet at the Institute. The inquiries come partly from Government Departments or from abroad, and partly from firms at home.

"Again, let an example serve. The Department of Agriculture in Sierra Leone wrote to the Institute about a project for growing limes for the production of concentrated lime-juice; they wanted advice on prospects and machinery. The Intelligence Bureau, knowing the details of a similar experiment carried out in the West Indies, sent Sierra Leone a complete description of the experience gained there, together with cost and details of the plant necessary to build up an industry.

"The daily callers at the office are numerous, and their questions, as a rule, rival the variety of their own occupations. Only during a 'boom' does any likeness occur in these inquiries. Not long since there seemed a simultaneous ambition in young men, ex-soldiers, to grow flax in Africa. It was then sometimes noticed, after queries had been satisfied, that the querist was ignorant of the very nature of flax. This, however, is not the ordinary experience of the bureau, the members of which have to use all their wits, all their knowledge, all their acquaintance with the books and pamphlets in their library, and all that elaborate card-indexing can do for their assistance, to meet the often abstruse demands made on them. The quarterly *Bulletin of the Imperial Institute*, together with monographs

and maps showing the resources of the Empire, is an illustration of the more defined intelligence work, which, in its totality, possesses an inestimable value, intimately associated as it is with an expert staff for research and with a comprehensive exhibition of products.

"The practical effectiveness of the Investigation and Intelligence Branches of the Institute owes not a little to the various advisory committees of specialists and commercial men who co-operate in their work. On one of these are representatives of the principal chambers of commerce, while others include leaders in the industries and trades in the various materials which form the basis of the Institute's operations."

Empire Trade Teaching

"It has been the work of many years to bring the Exhibition Galleries of the Imperial Institute to anything like the representative standard contemplated by the founders. All this time the productions and trade of the Empire have been increasing; the difficulties, financial and other, have been great; and only to-day can it be said that the collections illustrate our Imperial resources. If in one sense they are now complete, it must be remembered that they can never be considered final as long as the Dominions and Colonies continue to develop. Every country in the Empire has assisted, while the King and Queen have taken a personal and active interest in the equipment of the galleries. The Prince of Wales allowed the presents and addresses received from the Dominions and Colonies he had visited to be specially shown, and these are now to be included in the permanent exhibition. Among the many who have taken advantage of what the galleries have to teach is Princess Mary.

"Princess Mary, hearing of the guide-lecturer, gathered a party of her friends, and in a series of visits toured the Empire in the way the galleries enable one to do. Her example is followed by people generally and by schools. Already over 4,000 boys and girls from elementary, secondary, and public schools have been with their teachers or have followed the guide-lecturer on the special days arranged for them. The demand, both from schools and the public, is indeed greater than can be met by the present arrangements. Parties were at first limited to twenty, which had to be increased to twenty-five, and then further extended to thirty; and even so the services of the one member of the staff who can be spared to act as conductor are insufficient to the requirements. Economy has hitherto prevented the opening of the galleries on Sunday, and

caused their early closing in the dark months. There are many visitors who use the collections for trade purposes and for information on countries they intend to visit or settle in. Apart from this public employment, the galleries form the starting-point for researches by the staff for the utilisation of the raw materials of the Empire, which were described in a former article on the Imperial Institute in *The Times* of December 2.

"Nowhere else under one roof can one get so wide an insight into the present position and resources of all the countries in the Empire. There is no exaggeration in saying that a week in these galleries—a week, because there are many of them, and they are long—would provide the apt student with more direct, exact, and assimilable knowledge than could be gained by years of travel. Travel, of course, brings experience which no examination of exhibits can give. But exhibits can be so arranged and supplemented as to impart some of the pleasant novelty of going about the world; and this is the method adopted at the Imperial Institute.

"To each country, or group of countries, is allotted a section of its own. There are displayed, under glass, specimens of its products and the multifarious articles into which they are manufactured; while labels supply clear information of their constitution, properties, and uses. Near the specimens are large photographs, paintings, or transparencies on the windows, of the lands they come from and the native inhabitants. Large scale maps hang on the walls for consultation, and diagrams of every possible ingenuity show the course of production and trade through the years. South Africa, New Zealand, Victoria, and South Australia are among the countries which have recently added to and improved their exhibits in the Galleries. Canada is spending a large sum on the complete reorganisation of the Canadian section; the Crown Colonies and Protectorates have shown increased interest, and one of the results seems to be a healthy rivalry in inventing the best methods of Imperial advertisement.

"A few examples must suffice. They range from large oil paintings of Canadian scenery, homesteads, and cattle to the pile of gilt cubes (each representing 10,000 oz.) which keeps pace with the South African output of gold. Between these two extremes are models of towns and harbours, of the mechanical device by which New Zealand frozen meat is loaded in the ships, of the working of the Kimberley diamond mine, of a hundred other things and places. In one large case can be seen Canadian fruit preserved in a special liquid which keeps strawberries red and

peaches bloomy for an indefinite period. In the next are apples, pears, and plums imitated so exactly in wax that nobody could tell they were not real, unless he tried to eat them. The new Egyptian section, not yet complete, in which the delegates recently in London are said to have shown a very proper pride, contains beautiful specimens of carpet and wood work, in addition to a fine collection of Egyptian cotton, and among the treasures of the Sudan are models of the grain market at Omdurman and of Port Sudan, so hot and sandy, when the electric light is switched on, that one feels positively there.

" These are not mere prettinesses, but aids to the imagination. They contribute their legitimate share to the great variegated picture of the Empire, in its general as well as its commercial aspect, which is the purpose of the Galleries. They complete the story of the plant or mineral from its beginnings in nature to its end in the service of man. Thanks to them, the visitor can study the land whence comes the thing he is concerned with, the appearance of the folk who help to cultivate or mine it, the houses they live in, the clothes they wear. It is like a vast panorama, rigidly accurate, variously charming. To view it is to increase enormously one's perception of the wealth of the Empire, suggested here by a pile of bright tin containing preserved fruit or fish, there by a piece of pottery, and yonder by columns of timber meaning both furniture and paper. These Galleries were one of the principal objects for which the Imperial Institute was started, and the Director has had a big task in bringing together, arranging, and describing the exhibits from every quarter of the globe.

" The extensive Indian section is enriched by many loans from the King and Queen. Some of these are exquisite specimens of native art and handicraft, presents to their Majesties during their Indian visits and on other occasions, work in wood and metal, fibre, ivory, and silk. An example of old Indian carving occurs in the pillars and door from a house in Lucknow, half burnt during the Mutiny and preserved here for their historical and industrial significance. The intention is a reminder that even in this section devoted to Indian industries the chief aim of the Galleries, the severely or the æsthetically practical, is never missed. A few steps away you get the reminder again. A case of exquisite little things in bronze testify to the cleverness of Burmese boys under European instruction. Their teacher is an enthusiast, and their work vindicates him. Then, in the Ceylon pavilion, designed and decorated after the Cingalese fashion, at the instance of the Ceylon planters, comes a kindred lesson in the variation of civilisa-

tion. The pavilion may be a relation of the neighbouring galleries, but it demonstrates the independence of the art of Ceylon and illustrates the growth of Ceylon industry.

"The Imperial Institute needs more space. It is cramped by the arrangement of earlier days that made it the host, as to much of its accommodation, of the University of London. Yet there is a proposal—perhaps it is no more than a rumoured proposal—to overwhelm it with the Imperial War Museum, when that leaves the Crystal Palace. To judge of the wisdom of crushing out, or even crippling, the Galleries, it is only necessary to go through them."

The following notice regarding the work of the Imperial Institute appeared in the *Times Weekly Edition* of December 9, 1921:

"The wonderful work for the Empire carried on at the Imperial Institute is still inadequately realised by the great majority of people. The exhibits in its galleries alone deserve a series of articles, but perhaps even more important is the scientific examination of samples and the distribution of intelligence carried on at the imposing buildings in South Kensington. In some corner of the Empire a man thinks he has come on a good thing. He may write direct or seek advice from the nearest Government office. In either event, if the good thing is not chimerical on the face of it, a specimen, accompanied by an inquiry, is addressed to the Imperial Institute. There experts analyse it, experiment with it, consult manufacturers and merchants, and, in due course, the discoverer is furnished with all that there is to be known about its merits and possibilities. It is not surprising to learn that many new and prosperous industries have been set going by these means.

"Here are but a few examples of the way in which waste products of the Empire have been turned to useful account, with the assistance of the experts at the Imperial Institute. New Zealand has a good deal of waste wood, which, the Institute suggested, might be turned into paper-pulp or employed in distillation. Experiments on a small scale were made with the samples sent home; the New Zealand Government were informed that the yield of pulp and paper was quite promising; and the paper made in the laboratories can be examined in the Institute's very modern museum. The Forestry Department of the Dominion is now looking into the suggestions sent out by the Institute. A similar course was pursued with the acacia pods from the Sudan, also to be seen here, and

these pods are now sold as a tanning material in London. Other problems either solved or in process of solution are the utilisation of cotton-stalks, the best method of improving the tobacco of Nyasaland, South Africa, and elsewhere, and African wild silk. The last offers some fascinating exhibits, whether one regards the busy insect or the stuff which is the ultimate outcome of its endeavours. As an instance of the inquiries which reach the Institute, there was a project for growing limes for the production of concentrated lime-juice in Sierra Leone. Advice was sought on prospects and machinery. The Intelligence Bureau, knowing the details of a similar experiment carried out in the West Indies, sent Sierra Leone a complete description of the experience gained there, together with cost and details of the plant necessary to build up an industry. Such cases could be multiplied almost indefinitely."

The following article on the Imperial Institute, by Sir William Schooling, K.B.E., is reprinted from *The Daily Telegraph* of April 19, 1922:

"COURTS OF EMPIRE

"Portugal and Spain, France and Holland, had established colonial empires before the expansion of England began; and the English, while the last to found an Empire overseas, were the first to lose it. The duration of that first Empire lasted from the colonisation of Virginia in 1606 to the year of American Independence. The loss of the New England Colonies left the British with comparatively few possessions overseas, but since those days so vast an Empire has been built up that we have almost forgotten the lateness of our start, the failure of our first effort, and the salutary lessons which attached to it.

"The early adventures of European nations were mainly stimulated by the desire to obtain the real and fabled wealth of the East. They were also largely dominated by the idea that the best road to the East was across the Western Sea. When Columbus reached the coast of America he thought he had reached the shores of India, and consequently called the natives "Indians." The explorers of the North American continent persisted in their efforts because they hoped to find on the other side a narrow Western Sea, across which were the shores of China and Japan. Their geographical notions were mistaken, but they unexpectedly found in the new countries sources of wealth and welfare greater than any that could have been reaped from the realisation of their wildest hopes of the riches of the East.

"If individuals were greedy for wealth and, if we choose to say that such greed was a somewhat ignoble motive, we must recognise on the other hand that this was counterbalanced by a splendid spirit of adventure, by countless hardships and acts of bravery, and, as events turned out, by discoveries of far-reaching value and importance for the British race.

"For Governments, at any rate, it is appropriate to seek the increase of national wealth, for nothing is clearer than that the development of the commerce, industry, and wealth of a country increases the welfare of its people. As we study the history of Colonial administration, we are continually struck by the selfish attitude of the Mother-country, by the failure to understand the needs and the dispositions of the British overseas, and of the greater importance that was attached to political squabbles in Europe or in the United Kingdom than to the vastly more momentous concerns of our continually expanding Empire.

"It is only in comparatively recent years that larger and juster views have prevailed, and that great self-governing Dominions have come to take their rightful place in the affairs of the British Empire. Even to-day, however, the majority of the people in the United Kingdom know far too little of the history, the resources, and the geography of the outlying parts of the Empire.

"It was a happy inspiration of King Edward to bring about the foundation of the Imperial Institute as a memorial of the Jubilee of Queen Victoria. The familiar building at South Kensington was opened, but the methods of development at first adopted were not altogether successful. In 1903 the Institute was reorganised, and has since been carrying on three definite functions which, as they become more fully developed, cannot fail to prove of the utmost value to the Empire.

"For the average member of the public the Exhibition Galleries are of the greatest interest. They provide a permanent display of the chief resources of all the countries of the Empire. Here we can see paintings and photographs of cities and towns, scenes of industry, natural features, and the mode of life of the various people. Here are displayed specimens of timber, minerals, plants and other products of these British lands. As we wander through these Courts of Empire with an understanding and imaginative mind, we find them to be not only of absorbing interest, but to suggest almost endless possibilities of development for the benefit of the Empire at home and overseas.

"It is no criticism of the present Council of the Institute to point out how unworthy and comparatively trivial these exhibitions are. In the mere matter of space we find that the Dominion of Canada is represented by one square foot for every 300 square miles of territory, while Kenya, of which it is so important we should learn much, has but one square foot in which to represent the products and activities of nearly 700 square miles of territory.

"There are few developments of more importance at the present time for the benefit of the Empire as a whole, and the United Kingdom in particular, than a well-planned system of emigration from the Home Country to the overseas lands of the Empire. For stimulating this and for giving potential emigrants a clear understanding of the character and possibilities of each country, nothing could well be so serviceable as to make these Courts of Empire even more comprehensive and interesting than they at present are. It may be that for the moment such handbooks and descriptions as are available leave a good deal to be desired, but because the significance of Empire has not been adequately grasped, the Council has been systematically struggling with the difficulty of insufficient funds for all the activities which it would but too readily undertake if it could. Even as it is, it is a striking scene to witness groups of school-children being conducted round these Courts of Empire, under the charge of a guide-lecturer, who gives reality and vividness to the objects which are displayed, and can tell something of the nature and the possibilities of the countries from which they come. The Empire tends to become a reality to these young students, many of whom, it may be, will be influenced by these visits to the Imperial Institute to seek their fortunes overseas, to their own advantage and to that of the Empire as well.

"The Exhibition Galleries, however, are only one feature of the work of the Imperial Institute. The pioneers of Empire, as we have said, were stimulated by the desire for the gold, spices and precious stones of the ancient East. The Imperial Institute is seeking equally, but by very different methods, to make available the as yet but little explored wealth of the Empire. It has a scientific and technical department, equipped with extensive laboratories and workshops, for the investigation of raw materials and the uses to which they can be put. These studies are of an entirely practical kind. While working by the methods that modern science has placed at the disposal of the investigator, the problems dealt with are not those

of scientific research, but of practical utility for the commerce and industry of the Empire.

"The Institute has been largely instrumental in proving that minerals which abound in various parts of the Empire can be utilised for many purposes, such as the manufacture of gas mantles and of special steels, and so industries have been developed which were previously in other hands. Numerous sources of paper pulp have been found throughout Africa, New Zealand and elsewhere.

"The Empire is extraordinarily rich in timber, and as we walk through the courts of the various countries we can see the woods which each of them produce; and so we could pass from one subject to another, showing how, by investigation, by analysis, and by suggestion to experiment within the Empire on growing or producing things hitherto only found outside, the Institute has been developing various British countries and helping to expand the trade and industry of the Empire. In doing this it has the assistance of strong technical committees of manufacturers and experts of many kinds. One may be concerned with jute, wool, or other fibres, another with food grains, yet others with resins and essential oils; with drugs, tobacco, and spices; with hides and tanning materials; with mineral resources; with rubber; with silk production; and with many other subjects.

"The investigations in the laboratories having given some promise of success, manufacturers in this country, or elsewhere, are invited to test the products, or the processes, on a commercial scale, and thus time after time new industries have been developed and new sources of wealth have been discovered.

"Not the least important of the activities of the Imperial Institute is the intelligence which it collects, reviews and distributes. It publishes a quarterly BULLETIN which gives a summary of the principal investigations that have been carried out, describes progress in the utilisation of raw materials and in the production of mineral, agricultural and forest products. Handbooks and monographs of minerals, vegetable fibres, and other raw materials have been also issued, and the Intelligence Department receives and answers enquiries that are continually being received from all parts of the world.

"The Institute is definitely Imperial, and receives support, financial and otherwise, not only from a small endowment of its own and from the Home Government, but from the Dominions and Colonies as well. Situated in London, the centre of the Empire, it is able to do, and it is doing so far as its scanty resources permit, work

which cannot be accomplished elsewhere, and which is vital to the development of the resources and trade of the Empire. Much of the work can only be understood and appreciated by manufacturers and traders on the one hand, and on the other by those in distant lands who produce the various products, the value of which they learned for the first time from the thorough but unobtrusive work of the Imperial Institute.

"The exhibition galleries, however—The Courts of Empire—can be appreciated by any visitor who will take the trouble to examine them with a certain modicum of intelligence, in spite of the fact that sufficient has not yet been done in the way of handbooks and descriptions to make the full significance of the exhibits readily and adequately appreciated. This lack, however, is made good when parties of people, especially perhaps of children, are conducted round the exhibition by a guide who will tell them the true meaning of the things they see.

"As a Government and as a people, we in Great Britain have as yet no conception of the characteristics and resources of the British Empire, and far too little of an intelligent and appreciative Imperial spirit. Much can be done to remedy these defects by making the fullest use of the Imperial Institute. With the knowledge that would thus be gained there would come a greater interest in, and sympathy with, the British overseas, with the result that the bonds of Empire would be more closely knit.

"If the work of the Institute is permitted to expand it will reveal untold sources of hitherto unsuspected wealth throughout the Empire, and by the application of the methods of science and the organised assistance of industries at home and abroad will enable the wealth of the Empire to be made available for its welfare. An advantage less tangible, but not of less value, is that the Institute may teach the significance of Empire to the people of the United Kingdom as well as to visitors from overseas. Not the least of the services that it may be able to render is the encouragement of a well-considered plan of emigration of men and women who have learnt beforehand the possibilities of the lands in which they propose to settle."

Visit of the King and Queen to the Imperial Institute.—The King and Queen visited the Imperial Institute on Thursday afternoon, March 9. Their Majesties, who were attended by the Dowager Countess of Minto, Lord Stamfordham and Captain Sir Bryan Godfrey-Faussett, were received by Lord Islington, Chairman of the Execu-

tive Council, and Professor W. R. Dunstan, Director of the Imperial Institute, and spent about two hours in making a complete tour of the Exhibition Galleries and examining the exhibits from the different countries of the Empire, beginning with the new Canadian Section, which is now being completed, the Courts of the African Colonies, and ending with the Indian, Australian and South African Sections.

Her Majesty the Queen gave an order for the purchase of two Bedouin Rugs, of which examples are shown in the new Egyptian Court.

The presents made to the Prince of Wales during his recent Dominion tours, many of which are now on exhibition, were inspected by the Royal party.

On leaving the Institute their Majesties expressed their pleasure and satisfaction at the completeness of the galleries and commented on their educational value.

The Late Viscount Harcourt.—By the sudden death of Viscount Harcourt on February 24, 1922, the Imperial Institute loses a loyal friend and supporter. On the day before his death Lord Harcourt attended a meeting of the Executive Council and spoke strongly against the proposal to occupy a large part of the Exhibition Galleries for the purpose of housing the exhibits from the War Museum now at the Crystal Palace. As Secretary of State for the Colonies from 1910 to 1915, Lord Harcourt showed great interest in the operations of the Imperial Institute and his desire to strengthen and extend its work. In 1914 he presided at one of the meetings of the International Congress of Tropical Agriculture held at the Institute in that year, and also received the guests at the evening reception to the delegates and members which was held in the Exhibition Galleries after the Government Banquet.

Lord Harcourt was responsible for planning the Imperial Institute Act of 1916, and, though he had left office as Secretary of State before the Bill was introduced by the Government, he took an active part in its passage through both Houses of Parliament. In 1917, on the death of Viscount Rhondda, Lord Harcourt became Chairman of the Mineral Resources Committee of the Institute, and was a regular attendant at the meetings and an active co-operator in all its work.

Indian Trade Enquiry. Reports on Lac, Turpentine and Rosin.—A new volume dealing with lac, turpentine and rosin in the series of Reports of the Indian Trade Enquiry conducted at the Imperial Institute has just been

published by Mr. John Murray (price 5s.). It contains much information relating to the trade in lac and to the relatively new turpentine and rosin industry of India, in addition to the recommendations of a Special Committee of the Imperial Institute, which investigated the possibilities of further commercial employment in the United Kingdom of the materials in question. The volume consists of four parts: I. Report of the Trade in Lac; II. Supplementary Report on the Lac Trade of Burma (with an appendix); III. Report on Indian Turpentine and Rosin (with appendices); IV. Production of Turpentine Oil and Rosin in India, a summary of special information prepared at the Imperial Institute.

Potash: Imperial Institute Monograph.—A volume on Potash in the Series of Monographs on the Mineral Resources of the Empire, issued under the direction of the Mineral Resources Committee of the Imperial Institute, has been published (price 6s. net). The monograph has been prepared by Sydney J. Johnstone, B.Sc. (Lond.), A.I.C., of the Imperial Institute, and is a new and greatly enlarged edition of a monograph issued during the war.

The book, of 122 pages, is divided into eleven chapters, in the first five of which are given detailed descriptions of various deposits of soluble salts of potash throughout the world, including those of Germany, France, Abyssinia, United States, India, Tunis, Peru, Chile and South Africa. The remaining chapters describe other sources of potash, including insoluble minerals, such as alunite and felspars, flue dust from cement and blast furnace plants, and various animal and vegetable materials. Many analyses and much statistical information are included in the volume, which concludes with a bibliography of recent literature.

Manila Hemp: Cause of Damage in Recent Consignments.—In connection with the investigation of the Imperial Institute on the cause of damage in Manila hemp (this BULLETIN, 1921, **19**, 127, 378) much interest attaches to two notes which have recently appeared in *The Cordage World* (February, 1922, page 40).

The first of these notes refers to an interview in Washington of Mr. Alfred Wigglesworth (of the firm of Messrs. Wigglesworth & Co., Ltd.) with an officer of the Bureau of Agriculture of Manila, who pointed out that the serious fall in prices in 1918 after the armistice led to the storage of large quantities of fibre, pending

grading, baling and shipping. At that time 300,000 bales of hemp of the " J " grade, which is the quality that has shown the greatest deterioration, had been packed and stored, and it was acknowledged that some of the consignments which have reached London had been in storage for a year, or, in some cases, for even two years. Further, it was stated that the hemp is stored in the Philippines in unventilated buildings with corrugated iron roofs, in which the temperature becomes very elevated during the hotter part of the day. These conditions of storage of fibre, not always properly dried, would doubtless accelerate fermentation and consequent deterioration.

The second note quotes a report issued by one of the experts of the Bureau of Science in Washington, which states that large quantities of hemp are imperfectly dried before they are baled, and that the buildings used for storage are frequently at the optimum temperature for bacterial fermentation. It is believed that the cases of pronounced deterioration were due to the micro-organisms which accumulated during prolonged storage, much fibre having been held back for an improvement in prices. The lower grades of Manila hemp, such as the " J " grade, are more susceptible to bacterial fermentation than the higher qualities, as they contain a larger proportion of pulp or parenchymatous tissue (composed mainly of cellulose) which is much more readily attacked by bacteria than is the true fibre (composed of lignin). At the Bureau of Science, several micro-organisms have been isolated from deteriorated hemp, which will grow vigorously on pure cellulose, provided that sufficient moisture is present. It is therefore concluded that the deterioration of Manila hemp could be lessened by (1) artificial inhibition of the micro-organisms, (2) careful drying of the fibre and maintaining the bales in a dry condition, and (3) avoidance of long storage in damp, unventilated buildings.

These notes are thus seen fully to confirm the conclusions arrived at as the result of the investigation of the damaged Manila hemp at the Imperial Institute and recorded in this BULLETIN (1921, **19**, 131).

The Work of the German Colonial Economic Committee (Das Kolonial-Wirtschaftliche Komitee).—Prior to the war many references were made from time to time in this BULLETIN to the useful work accomplished by the German Colonial Economic Committee (Das Kolonial-Wirtschaftliche Komitee) in the development of the natural resources of the German Colonies. In view, however, of the fact that

Germany no longer possesses any Colonies, the question arises as to whether there is any justification for the continued existence of the Committee.

This matter was dealt with in a pamphlet issued by the Committee last year, which was written by Dr. Wilhelm Supf and is entitled *Das Ende deutscher Kolonialwirtschaft?* This publication gives a brief statement regarding the mode and date of acquisition of the various Colonies formerly held by Germany, and refers to the work done by the Committee in connection with their commercial and industrial development. Attention is drawn to the fact that the Committee was the first organisation to devote attention to the possibilities of cotton production for export in the countries of tropical Africa (cf. this BULLETIN, 1904, **2**, 249), their efforts in this direction being shortly followed by similar efforts on the part of the British Cotton Growing Association and the French Association Cotonnière Coloniale.

After fully considering the present position, the Committee has arrived at the conclusion that the organisation which has been built up during the twenty-five years of its existence is too valuable to be discarded, and it has, therefore, been decided that in future the Committee shall undertake the following tasks in conjunction with certain departments of the German Government.

1. To make investigations on the production of the tropical and sub-tropical raw materials of importance to Germany according to countries of production and their productive capacity.

2. To test the possibilities of these raw materials for the purposes of German industry and agriculture.

3. To carry out periodical investigations into the position of the most important raw materials in the world's markets.

4. To test the possibilities of German influence on the production and marketing of raw material by direct and indirect promotion of German enterprise in the producing areas and, in given cases, to undertake actual operations.

5. To influence all German interests concerned in the production, marketing and utilisation of raw materials to combine in the direction of a single purpose and a single policy.

In addition to these functions, the Committee will continue to assist German undertakings which still exist in the Colonies, although under foreign rule; they will be ready to afford both advice and practical help and, so far as their means permit, to serve the interests of the community.

The Committee's publication, *Der Tropenpflanzer*, has continued to appear in spite of the war, but the size has

been much reduced. In general, the contents of each number are of a similar character to those of the pre-war issues, but the articles are, of course, inferior in value to those formerly contributed by experts working in the German Colonies. In addition to short general articles on problems connected with tropical agriculture and the production of raw materials, the paper contains notes on the position of German Colonial Companies, short extracts from other publications, notices of new books, and Hamburg market reports. In general *Der Tropenpflanzer* is a valuable publication, although naturally its scope and usefulness have been greatly curtailed since the disappearance of the German Colonies.

RECENT PROGRESS IN AGRICULTURE AND THE DEVELOPMENT OF NATURAL RESOURCES

In this section of the BULLETIN *a summary is given of the contents of the more important papers and reports received during the preceding quarter, in so far as these relate to tropical agriculture and the utilisation of the natural resources of the Colonies, India and the Tropics generally. It must be understood that the Imperial Institute accepts no responsibility for the opinions expressed in the papers and reports summarised.*

AGRICULTURE

FOODSTUFFS

Maize.—The chief causes of low yields of maize in the Union of South Africa are discussed in *Journ. Dept. Agric., Union of S. Africa* (1921, **3**, 507). From the figures quoted for the average yields of maize in bushels per acre for the principal maize-growing countries, it is seen that Canada heads the list with 54·39, followed by Egypt 38·83, Argentine 32·55, Hungary 29·26, Bulgaria 28·19, Italy 27·01, Spain 26·67, United States 25·84, Australia 24·89, whilst South Africa appears at the bottom of the list with a yield of 14·29 bushels per acre, which is approximately equivalent to four bags. It is pointed out that this low yield does not represent merely the average obtained by maize farmers in the areas particularly suitable for maize, but is the average for the whole area planted in the Union, including that sown by the natives. The following are some of the main factors contributing towards the low yields: (1) Irregular and often insufficient rainfall. This is regarded as the greatest limiting factor in the production of maize in South Africa. In the Springbok flats area, in a good rainy season yields of twelve to fifteen bags per acre are not uncommon, whilst in dry years, which are not

infrequent in those parts, the average for the same land would probably be less than half a bag. (2) Poor soils. (3) Improper preparation of the seed bed. (4) Poor seed. (5) Failure to practise crop rotation. As there is proportionately only a very limited area of the country suitable for maize growing, and as attempts are made to grow it practically everywhere, whether climate and soil conditions are suitable or not, the low average yield per acre in South Africa can be readily understood.

Rice.—A comprehensive account of the rice industry of the Philippines is given in *Philippine Agric. Rev.* (1921, **14**, 1). The methods of cultivation and the local conditions are fully described, and a long list of the varieties of rice grown in the islands is given. The list records the yield obtained over a number of years for each variety, and includes a short description of the varietal characters. Harvesting, threshing and the process of preparation in the modern mill are described, and the cost of production is discussed. An account of the rice bug (*Leptocorisa acuta*, Thunberg) occurring in the Philippines is also given, and remedial measures, including the encouragement of the natural enemies of the insect, trapping, and spraying with contact insecticides, are described.

Diseases of the Banana.—No. 48 (1921) of *Mededeelingen van het Inst. voor Plantenziekten* deals with a vascular disease of the banana first observed in 1915 in Java in the neighbourhood of Buitenzorg. In most cases of attack, no external change in the appearance of the plants is noticeable, but internally the vascular bundles are discoloured, this being most apparent in the rhizomes, from which the discoloration extends upwards. In relatively few cases external symptoms, such as poor growth of the heart leaf, splitting of leaf-sheaths and wilting of leaves, are manifested. These symptoms are, however, not specific, since nearly all diseases of the banana produce similar symptoms, while the internal symptoms agree with those of the Panama disease. The most important banana diseases are reviewed and compared with the Java disease under consideration. All the wilt diseases of the banana, agreeing in their internal symptoms and occurring wherever the banana is cultivated, are grouped by the writer as diseases of the Panama disease type. In the writer's opinion they are primarily caused by parasitic bacteria in the vascular bundles, whilst secondary complications ensue, owing to fungi of the *Fusarium* type entering the diseased bundles from the soil. The Panama disease itself

is distinguished from others of the group by the presence of *Fusarium cubense*, Smith, which by its toxic activity effects the death of the plant, whilst the Java vascular disease has not caused any serious damage.

Though the Java disease is of little economic significance, it was closely studied in connection with the investigation of the more serious blood disease of the banana which has caused considerable damage in Celebes. No. 50 (1921) of *Med. van het Inst. voor Plantenziekten* deals with the latter disease. Its characteristic symptoms fall into two groups—(1) those affecting the leaf-crown, and (2) those involving the fructification. The effect on the leaf-crown begins with the appearance on one of the younger leaves of yellowish-brown stripes, commencing at the mid-rib, and extending in some cases to the margin of the leaf. This condition, with only one leaf or at the most two discoloured, may last for a long time, and the fruits may appear to be almost completely developed, when suddenly the whole leaf-crown turns yellow, and the leaves subsequently break down. The internal symptoms in the rhizomes and stems are the same as for the Java vascular disease, but the changes which are manifested in the fruits are specific of the blood disease. The central vascular bundles of the fruit become yellow or brown, the discoloration eventually extending into the placentæ and parenchyma and even the bundles of the fruit rind. The entire fruit finally turns yellow, the interior becomes filled with a slimy red fluid, and the fruit droops and decays. The cause of the disease is a bacterium which penetrates into the fruits from the rhizomes. Young plants become infected from the mother plant, whilst the disease may spread into healthy rhizomes from infected soil. Dissemination of the disease by the agency of insects or the wind has also been observed, bacteria entering the flowers through the stigma. The study of control measures is in progress, but it would appear that since so many varieties are susceptible to the disease, the prospects of producing immune varieties is not promising.

Moki Lima Beans.—In *Bulletin* No. 9, 1921, *Tech. Sect., Sultanic Agricultural Society*, an account is given of trials that have been made in Egypt with this group of lima beans (*Phaseolus lunatus*). These beans, although probably of South American origin, have been grown for a long period by the Moki Indians of Northern Arizona. They are apparently a distinct horticultural group of the Sieva type of lima beans. The group includes varieties with white, buff, red and variegated seeds, and is well

ıdapted to hot, dry climates. The plants are characterised ɔy a semi-dwarf habit of growth, with non-twining vines ɔf moderate length, which permit their cultivation as a ïeld crop. In Lower Egypt they set full crops of seed :hroughout the summer, and, with irrigation, yield up to ɔ10 kilos of beans per feddan (17½ cwts. per acre). On ıccount of its drought-resistant properties, the plant is of value as a dry farming crop. Insect pests and plant diseases so far have not seriously menaced the crop. The *Bulletin* gives a full account of the plants and their cultivation, with records of yields and analyses of the beans.

Oils and Oil Seeds

Oil Palms in the Belgian Congo.—An account is given in *Bull. Agric. du Congo Belge* (1921, **12**, 522) of the exploitation of the oil palm resources of Barumbu, near the Equator in the Belgian Congo. Plantations have been made at Barumbu, mostly with palms of the variety known locally as "Moehei"; but these are still young, the trees being for the most part from one to two years old, and at present the commercial source of palm fruits is a small portion of the natural palm forests and the trees which are growing on old native plantations. The palms in Barumbu are very numerous, and in some places the young trees form an almost impenetrable forest. The trees, to the extent of about 99 per cent., are of the type, or rather mixture of types, called "Mokokele," the remaining one per cent. being "Moehei." It is only from "Mokokele" trees that the fruit-clusters are gathered. After collection, the clusters are broken up and the fruit separated, care being taken to eliminate unripe or decayed fruits and all other extraneous matter. The cleaned fruits are collected every day by a little boat belonging to the Huileries du Congo Belge, by which they are taken to the factory at Elisabetha.

The annual contribution of palm fruits from the station of Barumbu to the Huileries du Congo Belge is estimated at 300–360 metric tons, the product of 470–564 tons of fruit-clusters, and this yields some 48–57·6 tons of palm oil and 26·3–31·6 tons of palm kernels, the latter calculated on the commercial basis of 5 per cent. moisture.

The proportion of cleaned fruits obtained from the clusters as gathered from the trees has been found to average 63·8 per cent. for the three types collectively called "Mokokele." In the case of the "Moehei" type it is from 52·2 to 55·3 per cent. The yield per tree has not been determined, but it is considered that 60 kilos per annum may

be regarded as a conservative estimate for the trees of the Barumbu forests, taking into consideration all those that are yielding, irrespective of their ages. It is thought that this yield would be largely increased if the trees were grown with proper care under plantation conditions. It is urged that when plantations are to be made, care should be taken to select high-yielding varieties instead of having recourse, as has too often been done in the past, to trees grown in the forest regarding whose record little information is available.

Safflower Seed in India.—Reference was made in this BULLETIN (1916, **14**, 474) to the botanical study of *Carthamus tinctorius* at Pusa. In connection with this work, a ton of safflower seed, grown partly at Pusa and partly in the neighbourhood of Behea near Patna, was sent to England in 1917 for full technical investigation, and a report on the results of this investigation is now embodied in *Bulletin* No. 124 (1921), *Agric. Research Inst., Pusa.* Trials were carried out with a modern benzene extractor with a view to finding the best working conditions, and recommendations are made as to the method of treating the seed which is most likely to give satisfactory results in commercial practice. The yield of oil obtained by this particular method was 20·58 per cent. and the oil remaining in the meal was only 2·21 per cent. The physico-chemical constants of the oil are recorded.

A series of tests with safflower oil as a drying oil was made with various commercial driers, cobalt resinate giving the quickest drying and cobalt acetate the second best result, whilst lead resinate was the slowest. In making varnishes safflower oil was found to have the advantage over linseed oil that it does not " break " or deposit foots even when heated to 315·5° C. Soap-making trials gave good results, and the use of the oil for this purpose in India is recommended. It should also be useful for the manufacture of linoleum. The oil was found to bleach well, and by a special cold process it was possible to obtain oil of a pale straw colour which, it is claimed, would be useful in making enamels and artists' colours. By removing the free fatty acids and decolorising the oil with fuller's-earth and animal charcoal, a pale yellow oil of edible quality was obtained.

The meal left after solvent extraction of safflower seed had the following percentage composition : moisture, 7·50 ; oil, 2·21 ; albuminoids, 15·96 ; carbohydrates, 35·48 ; crude fibre, 32·88 ; ash, 5·97.

The high percentage of fibre precludes the use of the

meal as a feeding-stuff, and it is suggested that it could be disposed of in India as a filler for soap or as a slow-acting manure.

In order to encourage further large-scale trials, a firm of shippers in Bombay have expressed their readiness to collect and ship consignments of the seed to this country, and the Agricultural Department of Bombay have undertaken to develop the cultivation of improved varieties in the Deccan if the demand should prove sufficient to warrant such action.

Mosaic Disease of Soy Beans.—A communication from the Botanical Department of Purdue University Agricultural Experiment Station, La Fayette, Ind., U.S.A., to the *Journal of Agricultural Research* (1921, **22**, 111) describes the symptoms exhibited by soy bean plants of the "Hollybrook" variety, in which mosaic disease was found in August 1920. An account is also given of experiments on the transmissibility of the disease. Attempts to inoculate healthy soy beans in the field, by rubbing the young internodes with cotton soaked in juice from the crushed leaves taken from affected plants, and then wounding the internodes with a needle, were in every case unsuccessful, but greenhouse experiments in transmitting the disease from affected to healthy seedlings by various methods gave a proportion of positive results. To determine whether the disease was transmitted through seed, seeds from affected and healthy plants were planted in pots of sterilised soil in greenhouses. About 13 per cent. of the plants from "mosaic" seed showed the disease, whilst in no case were mosaic disease symptoms found in the control plants from healthy seed. It is concluded that the mosaic disease of the soy bean is transmissible from plant to plant, and is also seed-borne.

Japanese Tung Oil.—This oil, the product of *Aleurites cordata*, is the subject of *Circular* No. 138, 1921, of the *Educational Bureau, Paint Manufacturers' Association of the United States*. After drawing attention to the description of the Japanese tung oil tree in this BULLETIN (1913, **11**, 457) as "probably the most accurate reference" to the subject, the writers give the results of their examination of authentic samples of the seed and oil from Fukui Province, Japan. The seeds consisted of shells 37 per cent. and kernels 63 per cent., and when extracted by solvents the kernels yielded 51 per cent. of oil of a light golden yellow colour. The oil, as received from Japan, gave the following constants: iodine value per cent.,

150·2 (Wijs), 154·4 (Hübl); saponification value, 193·2; acid value, 0·9; specific gravity at 15·5°/15·5° C., 0·9342; refractive index at 25° C., 1·4981. A number of other laboratory tests are recorded, and the conclusion is reached that the oil could be used to a considerable extent for the same purposes as Chinese tung oil.

Kurrajong Seed and Oil.—A chemical investigation of Kurrajong (*Brachychiton populneum*) has been carried out at the Agricultural Laboratory, Sydney University, by J. K. Taylor, B.Sc. (Agr.), at the instance of the New South Wales Forestry Commission, and a report on the work is now published in the *Australian Forestry Journal* (1921, **4**, 295). The seed contained 17·03 per cent. of oil, which is described as of a red colour, clear, and of the consistency of a heavy syrup. The constants of the oil were: acid value, 4·0; saponification value, 189·5; iodine value, 97·0 per cent.; acetyl value, 5·8; Hehner value, 94·5 per cent.; specific gravity, 0·9206; refractive index, 1·471; titer test, 26·8° C. The oil is of the semi-drying class, its position in that category being further confirmed by the results of comparative drying tests and the "elaidin" test. The press-cake gave the following percentage figures: moisture, 10·72; ash, 4·34; crude protein, 21·56; ether extract, 7·76; crude fibre, 19·05; carbohydrates, etc., 36·57; the albuminoid ratio was 1 : 2·5.

It is doubtful whether, even if the oil is edible, a fact which has not been experimentally proved, the seeds would repay collection, in view of their low oil content and of the facts that the trees are generally found more or less scattered and that the annual yield of seed probably does not exceed an average of 2–4 lb. per tree. Large-scale trials with the oil are proposed by the New South Wales Forestry Commission.

Rubber

Improving Latex Yields.—The *Bulletin of the Rubber Growers' Association* (1921, **3**, 299) published notes on this subject supplied by Mr. Roger Bannerman, the visiting agent of Messrs. Francis Peek & Co., Ltd., in Java. He recommends that much closer planting should be done in future to allow of more thorough selection for thinning out. The distance advocated is 10 ft. by 10 ft., which gives 410 trees per acre. Thinning should start from the second to the fourth year according to growth. The trees to be selected are decided on by mild experimental tapping for short periods. In addition to close planting, and thorough

selection, it is probable it will be found advisable to use grafts as the planting material. There is little doubt that the yields from such trees would approximate to the yields from the trees from which the grafting material was taken. Not only can the crops be increased by a system of grafting or budding, but also the powers of resistance of the trees to pest, blight and disease are improved.

If 410 trees were planted per acre and the planting material consisted of stumps grown from first-class seed and grafted with first-class material, and if eventually the stand per acre was reduced by careful crop selection, over, say, five years to about 70 trees per acre, the full maturity yield would be far superior to that now obtained.

If planting was carried out on these lines, it is estimated that the annual yield per acre would amount to 1,100 lb. of dry rubber, the f.o.b. cost of which on a sound Java estate would be about 3*d.* per lb.

All estates are advised to start grafting operations, even if on a small scale, so that the staff may be trained to the work.

A further article on the improvement of latex yields and the reduction of working costs is given in the same *Bulletin* (1921, **3**, 349) by Monsieur E. Girard. Details of experiments are recorded in which similar groups of trees were (1) tapped daily, (2) tapped first of all for alternate weeks and then for alternate 15 days and finally for alternate months, (3) tapped first of all 10 days in 30 and then one month in three. Under the alternate system, during the first 12 months there is a reduced yield of latex, and this is followed by a gradual recovery when the economy in cost becomes effective. In the case of daily tapping the yield falls off eventually, whereas with alternate tapping the yield will increase for a number of years, and the period of large yield will be doubled.

Effect of Coal Tar on Bark Renewal.—*Arch. voor de Rubber-cultuur* (1921, **5**, 495) contains a summary of experiments on the application of coal tar with a view to obtaining quicker bark renewal on the tapping surface. The conclusions arrived at are that (1) an increase in thickness of bark is obtained, (2) the increase is due only to the accelerated activity of the cork cambium, and (3) no increase occurs in the soft or latex-bearing portion. The regular monthly application of tar to the tapping area therefore cannot be advocated.

The same publication (1921, **5**, 549) contains an account of further investigations on the influence of tar on Hevea bark. The results of these experiments show that tar

has no adverse influence on bark renewal. It is suggested, however, that it should only be applied where the wood is exposed as in pink disease and die-back disease.

Rubber in Uganda.—A summary of a report on the production of Para rubber in Uganda is given in the *Uganda Official Gazette* (1921, **14**, Oct. 31, p. 507). Owing to climatic conditions the Uganda trees are behind their Malayan rivals. The greatest obstacle to rubber production in Uganda, however, is the general incapacity of the Uganda labourer. The production of rubber on a large scale is impracticable, but there is no reason that it should not prove remunerative as a subsidiary crop. Owners of plantations of 50 acres and upwards are advised to retain them, as their cost of upkeep is very small and clean weeding is not essential.

Rubber in Bolivia.—*L'Agronomie Coloniale* (1921, **6**, No. 46, p. 122) contains an account of the distribution of Hevea in the regions watered by the Amazon and its tributaries. It is stated that the best quality of rubber is not obtained from the province of Para in Brazil, but from a region between 10° and 13° S. latitude and 65° and 70° W. longitude at a distance of 2,000 kilometres from the sea. This region lies at an altitude of between 75 and 170 metres. The best latex is obtained from old trees. It is thick and creamy and should yield 50–60 per cent. of coagulum. After heavy rains the latex becomes thinner, is more difficult to coagulate, and gives rise to rubber lacking in homogeneity. When this occurs the seringueiro refrains from tapping the tree.

The search for the rubber trees is greatly facilitated by the numerous tributaries of the Amazon, and can be extended by steamer and rowing boat up to the foot of the Andes.

The Hevea trees are too high (minimum 25 metres) to be recognised by their leaves. The appearance of the bark is the only indication the collector has to guide him, and sometimes it is even necessary to tap the trees in order to determine their identity. Experience has shown that Heveas with a dark bark furnish the best latex.

Fibres

Flax.—In a note on flax growing in Kenya Colony (this Bulletin, 1921, **19**, 62), it was stated that the Flax Association had inaugurated a scheme for the grading of the fibre. Facilities for grading have now been arranged

by the Department of Agriculture under conditions which have been published in a *Circular on Flax Grading* (Nairobi, 1921). For convenience in grading the flax bundles must not exceed 14 lb. each. To all bundles graded tickets will be attached by the Flax Officer which will bear the Government brand (K) and the grade mark, tickets of different colours being used for dew-retted and water-retted flax. The following grades have been established.

Water-retted Flax

Warp.		Weft.	
Grade.	Mark.	Grade.	Mark.
No. 1	W.P.A.	No. 1	W.T.A.
No. 2	W.P.B.	No. 2	W.T.B.
No. 3	W.P.C.	No. 3	W.T.C.
No. 4	W.P.D.	No. 4	W.T.D.
No. 5	W.P.E.	No. 5	W.T.E.
Below Grade . .	W.P.O.	Below Grade . .	W.T.O.

Dew-retted Flax

Warp.		Weft.	
Grade.	Mark.	Grade.	Mark.
No. 1	D.P.A.	No. 1	D.T.A.
No. 2	D.P.B.	No. 2	D.T.B.
No. 3	D.P.C.	No. 3	D.T.C.
No. 4	D.P.D.	No. 4	D.T.D.
No. 5	D.P.E.	No. 5	D.T.E.
Below Grade . .	D.P.O.	Below Grade . .	D.T.O.

Water-retted Tow.		*Dew-retted Tow.*	
Grade.	Mark.	Grade.	Mark.
No. 1	W.A.	No. 1	D.A.
No. 2	W.B.	No. 2	D.B.
No. 3	W.C.	No. 3	D.C.
Below Grade . .	W.O.	Below Grade . .	D.O.

The fees payable for grading are fls. 30 per ton of flax and fls. 5 per ton of tow.

Jute.—A paper on "Some Preliminary Experiments with Jute in the United Provinces" has been contributed to the *Agric. Journ. of India* (1921, **16**, 618) by B. C. Burt, M.B.E., B.Sc., formerly Deputy Director of Agriculture,

Central Circle, United Provinces, and R. S. Finlow, B.Sc., F.I.C., Fibre Expert to the Government of Bengal.

An account is given of experiments which have been carried out on the tract known as the "ganjar" which extends through considerable portions of the Kheri, Bahraich and Saipur Districts, and consists largely of the land lying in the angle between the Sarda and Gogra rivers and the low land on either bank. Kharif cultivation in this tract is somewhat precarious owing to the variable nature of the floods and the varying deposits of sand or silt from the river. Winter cultivation also is limited by certain factors. When the floods recede late or the monsoon is prolonged, there is little time for the preparation of the land for rabi crops, and, except on manured land near village sites, the soil is of a light character and unable to retain sufficient moisture in years when there is no winter rain. On each side of the ganjar is the "terai," a class of land which is free from flooding, and is of admirable texture, with a high sub-soil water level.

It was decided to plant jute at various places throughout the ganjar area, including the edge of the terai, and arrangements were therefore made to grow the crop on tenants' fields in suitable villages of the Katesar and Rampur Mathura estates, the cultivators being guaranteed against loss. The Agricultural Department provided seed, manure (castor cake), and the necessary staff to supervise the preparation of the land, sowing, weeding and retting, and also undertook the marketing of the fibre produced.

In the Katesar estate, the work was centred round Shahpur, near the right (west) bank of the Chauka, but included villages farther west on the edge of the terai and farther east between the Chauka and Sarda. In Rampur Mathura, trials were carried out on the typical ganjar between the two rivers and near their junction.

Altogether about sixty plots were planted, the total area being about 12 acres. Both *Corchorus capsularis* and *C. olitorius* were tested, but attention was principally given to the former species.

It was found that, in the terai, jute requires irrigation, and it is therefore doubtful whether the crop could be successfully grown there on account of the large amount of labour involved in irrigating from small shallow wells. Moreover, maize can be grown on this land without irrigation. On the actual fringe of the river, jute cannot be grown owing to the excessive proportion of sand in the soil; but on land in the real ganjar area, where *Paspalum scrobiculatum* is grown and no kharif crop of importance can be produced on account of the uncertainty of the

degree of flooding, jute did extremely well without irrigation.

The experiments have proved that jute can be profitably grown on suitably selected land in this tract, but success in introducing the crop will depend on the attention given by the growers to cultivation and retting. The trials have aroused much interest in the Kheri and Sitapur Districts, but applicants for seed have been advised to await the results of another year's experiments in the Katesar and Rampur Mathura estates before attempting the cultivation.

Manila Hemp.—In an investigation at the Imperial Institute of certain samples of damaged Manila hemp (this BULLETIN, 1921, **19**, 127) it was found that the quantities of ash which they yielded varied from 3·7 to 5·1 per cent., whilst two commercial samples of good quality gave 1·1 and 2·4 per cent. of ash respectively. In this connection, it is of interest to note that the Philippine Bureau of Science at Manila has recently found that the percentage of ash varies with the grade of the fibre in such a way as to render the determination of the ash an approximately accurate method for ascertaining the grade (*Cordage World*, November 1921, p. 41). The percentages of ash yielded by the various Government grades of Manila hemp are as follows: A. Extra Prime, 1·14; B. Prime, 0·62; C. Superior Current, 0·99; D. Good Current, 1·33; E. Midway, 0·81; F. Current, 1·93; S1. Streaky No. 1, 1·62; S2. Streaky No. 2, 2·15; S3. Streaky No. 3, 1·31; G. Seconds, 2·03; H. Brown, 2·32; I. Good Fair, 2·46; J. Fair, 3·00; K. Medium, 4·10; L. Coarse, 4·56; M. Coarse Brown, 3·36; DM. Daet Coarse Brown, 2·76.

Sisal Hemp.—In this BULLETIN (1919, **17**, 477) an account was given of the attention which was being devoted to Sisal hemp cultivation in Jamaica, and a report was published of the results of the examination at the Imperial Institute of samples of fibre produced in the island. It is stated in the *Journ. of the Jamaica Agric. Soc.* (1921, **25**, 433) that about 4,000 acres have now been planted in Jamaica with Sisal hemp. There are 3,000 acres in the neighbourhood of May Pen, in the parish of Clarendon, where two factories have been erected, and the local manufacture of rope and twine is contemplated. At the Government Plantation at Lititz, on the borders of St. Elizabeth and Manchester, there were expected to be some hundreds of acres ready for cutting, and a factory has been established. A private factory is also at work at Hodges Pen in St. Elizabeth.

According to the *Cordage World* (September 1921, p. 37, and January 1922, p. 22), Sisal hemp cultivation is progressing favourably in Ceylon. It is stated that 670 acres are already planted, that capitalists in Colombo are taking steps to open up new estates, and that the industry is being extended in many directions. It is also reported that excellent lands for Sisal hemp are cheaply and easily obtainable. In order to encourage cultivation, the Ceylon Government has transferred on special terms to the Ceylon Hemp and Produce Syndicate 120 acres of Crown land, adjoining its present estate at Maduruwagama in the North Central Province.

Cotton

Egypt.—A pamphlet on "The Method employed by the State Domains for producing and maintaining their High Standard of Sakel Cotton," recently issued by the Ministry of Agriculture, Egypt (Government Press: Cairo, 1922), gives an account of the system of seed selection which was instituted in 1912 and has been carried on continuously to the present time. In that year the Domains purchased a quantity of the best and purest Sakel seed then available. The crop from this seed showed considerable variation in vegetative form and in the type of cotton borne by different plants, and it was realised that, unless active measures were taken, a rapid deterioration of the fibre would ensue, owing to the multiplication of the plants untrue to type and their hybridisation with the true Sakel type. A definite scheme for preventing such deterioration was therefore undertaken, and its results have surpassed expectation.

A certain area was planted with the purest seed obtainable, and during growth any plants which were not true to type were rogued out. Early in the season, trained children were sent into the fields in advance of the pickers, with instructions to pick only from typical plants of medium height, and with the largest number of fully opened, healthy bolls, bearing cotton of the correct Sakel colour; this operation affects the selection of seed of early maturing, heavy yielding plants of the true Sakel type. After picking, the cotton was spread out on sacking, and any cotton differing from the type in colour and general appearance was rejected. The cotton thus selected was ginned separately, every care being taken to prevent the introduction of other seeds by thoroughly cleaning the factory, the gins, the installation for destroying pink bollworm, and also the sacks.

In the following year this seed was sown on one or more farms, and the resulting seed again selected in the same way. The seed obtained from the produce of this second generation was distributed to cultivators.

This process of selection has been recommenced each year from 1912 to the present time, with the result that the Domains cotton is of the finest quality, and is in great demand by spinners of high-class cotton.

The high prices realised by the Domains cotton is due, however, not only to the purity of the seed used, but also to a special method of cleaning which is practised.

According to this method, the seed-cotton is passed over a table grid, 4 metres long and 1 metre wide. The bed of the table consists of slats of wood, 20 mm. thick and 13 mm. apart, arranged at right angles to the length of the table. The cotton is put on one end of the table, and is tossed about by children, five or six each side of the table, who pass the cotton from one to another in the direction of the length of the table, until it reaches the other end. Any dirt and " leaf " in the cotton fall between the slats, and the clean cotton is taken off from the farther end, any bad cotton or foreign material, which does not pass through the slats, being picked out during the process.

Uganda.—The Report of the Department of Agriculture, Uganda Protectorate, on the Cotton Crop in 1921, has been published as a *Supplement to the Official Gazette* of November 30, 1921.

The areas devoted to cotton in the various districts of the Protectorate in 1920 and 1921 are estimated as follows :

Eastern Province	1920. *Acres.*	1921. *Acres.*	*Northern Province*	1920. *Acres.*	1921. *Acres.*
Teso District .	65,000	47,000	Bunyoro District .	1,000	500
Busoga District	45,000	31,000	Gulu District .	1,500	1,100 ?
Bukedi District	44,000	30,000	Chua District .	500	100 ?
Lango District	26,500	20,300	West Nile District .	100	?
Total .	180,500	128,300	Total . .	3,100	1,700

Buganda Province	1920. *Acres.*	1921. *Acres.*
Mengo District . .	32,000	24,000
Entebbe District . .	10,000	6,000
Mubendi District . .	6,000	3,000
Masaka District . .	7,000	1,000
Total . . .	55,000	34,000
Grand Total . . .	238,600	164,000

The estimated production of cotton during the 1920–1921 season amounts to 75,000 bales of 400 lb. each. The following figures are compiled from the records of purchases made in each district.

Eastern Province	Bales of 400 lb.	*Northern Province*	Bales of 400 lb.
Busoga District	16,750	Bunyoro District	250
Teso District	14,350	Gulu District	300
Bukedi District	10,450	Chua District	80
Lango District	7,200	West Nile District	20
Total	48,750	Total	650

Buganda Province	Bales of 400 lb.
Mengo District	16,000
Entebbe District	5,000
Mubendi District	2,000
Masaka District	2,600
Total	25,600
Grand Total	75,000

The exports of cotton from Uganda during the last five years (April 1 to March 31 in each case) were as follows (in bales of 400 lb. each): 1916–17, 21,832; 1917–18, 27,854; 1918–19, 27,492; 1919–20, 36,530; 1920–21, 51,843. For the six months, April 1 to September 30, 1921, the exports amounted to 48,824 bales.

India.—The Agricultural Research Institute, Pusa, has recently issued, as *Bulletin* No. 123, a report on "The Bundelkhand Cottons: Experiments in their Improvement by Pure Line Selection," by B. C. Burt, M.B.E., B.Sc., Deputy Director of Agriculture, Central Circle, United Provinces, and Nizamuddin Hyder.

The Bundelkhand Division is separated from the rest of the United Provinces by the river Jumna, and its inhabitants and its soils are more like those of Central India. The Division now produces much less cotton than it did many years ago; but the crop, though small, is of importance to Indian spinners, owing to the existence of three commercial types which are superior to ordinary Bengals. These cottons are known by the general name of Jumnapar, but more commonly as Kalpi or Jalaun, Kulpahar, and Rath; a fourth type, termed Karwi, is sometimes recognised. The Kulpahar is the best of these, but is produced in comparatively small quantities. As the climate of Bundelkhand is characterised by greater

extremes of heat and rainfall than other parts of the United Provinces, a cotton for the district must be suitable for either irrigated or non-irrigated sowing, and capable of withstanding heavy rainfall.

A study of Rath, Kulpahar, Jalaun, and a Central Provinces cotton (Saugar Jari) has been carried out at Cawnpore, and pure lines have been isolated. The Rath cottons, however, were discarded comparatively early in the experiments, and Kulpahar also gave disappointing results. The selection from Jalaun cotton on the other hand exceeded expectations, and eventually a selection, known as J.N.1, was obtained, which has a length of staple of 0·85–0·90 inch, and gives a ginning percentage of 36 and a good yield per acre. Spinning trials have shown that this cotton is suitable for 16's to 18's warps, and 20's wefts as compared with 10's to 12's for ordinary Bengals.

This J.N.1 cotton was planted in 1920 on an area of 1,000 acres. It resembles the ordinary "deshi" cottons in bearing yellow flowers, but is distinguished from the latter by its broad-lobed leaf, characteristic habit and larger bolls. It gives a comparatively high yield in wet seasons, and appears to be suitable for several districts outside Bundelkhand, and adapted for sowing on both irrigated and non-irrigated land.

In the *Rep. Dept. Agric., Madras Presidency*, 1920–1921, reference is made to the work which has been carried on for nine years by G. R. Hilson, the Cotton Specialist, at the Nandyal and Hagari farms, and has resulted in the production of the excellent selected strains, N.14 of Northerns cotton and H.25 of Westerns cotton. In the Kurnool district, during the year under review, 330,000 lb. of seed of N.14 was sold by the Department and through the agency of seed unions, and about 30,000 acres were planted with this seed. If the season had not been unfavourable, it is probable that the whole cotton area of the Nandyal valley would have been planted with this type in 1921, but it will now require another year before this can be accomplished. In the Bellary district, 131,000 lb. of H.25 seed was sold, which is sufficient for 12,000 acres. In this case also the season was unpropitious, and the extension of the cotton is retarded.

The work at Koilpatti on single plant selections of Tinnevellies cotton has been continued, and some new types have been obtained which give better yields than the Company No. 2 and Company No. 3 now being distributed to the ryots.

The entomological section of the Department has

devoted much attention to the pink bollworm and the stem weevil. The pink bollworm has always been present in South India, but its depredations were not brought to public notice until 1918. The pernicious practice of growing Cambodia cotton as a perennial instead of an annual has led to an alarming increase in the prevalence of the pest, and in 1919 the Pest Act was put into force in the Coimbatore District, which provided for the compulsory uprooting of all Cambodia cotton plants before August 1. The extent to which cotton has become attacked in that area is shown by the fact that at the Central Farm from 75 to 84 per cent. of the bolls were found to be infested at the end of July 1919. The enforcement of the Pest Act, however, has caused a considerable improvement, the number of bolls infested at the end of July 1920 being reduced to 51 per cent. With regard to the stem weevil, investigations conducted in consultation with the Cotton Specialist have indicated that strains of cotton immune to this pest may be obtainable. Two natural enemies to the stem weevil have also been discovered.

Ceylon.—In 1910, during an official visit to Ceylon, Prof. W. R. Dunstan, C.M.G., F.R.S., Director of the Imperial Institute, made a careful study of the possibilities offered by Ceylon for cotton cultivation, more particularly in the northern parts of the island. In the course of his report on this subject, Prof. Dunstan pointed out that there are many districts in Ceylon in which it would be worth while to carry out systematic experimental work with a view to the establishment of an acclimatised type of cotton in the island.

In the *Ceylon Observer* (*Weekly Edition*, January 18, 1922) reference is made to an account given by the Director of Agriculture of cotton-growing experiments which are now being carried out by the Agricultural Department at Ambalantota and at Kiula in the Hambantota District. At Ambalantota, 50 acres have been planted with the following varieties: Cambodia and Karunganni from Madras; Durango and Cauto from the United States; Egyptian; and Sea Island from the West Indies. The Director of Agriculture reported that at the time of his visit to Ambalantota all these cottons were growing satisfactorily, and that the Sea Island was doing particularly well, he having seen but few better areas of cotton in the West Indies. The area at Kiula has a sandier soil than that of Ambalantota; 10 acres were planted and, except on one acre where growth was unsatisfactory, all the plants appeared healthy and promised good results.

The Director of Agriculture, while in the Hambantota District, also visited the Low-country Products Association's farm at Kirindi Oya. Cambodia cotton has been planted at this farm on an area of 1½ acres and has grown quite satisfactorily.

The Department of Agriculture of Ceylon has recently distributed 1,900 lb. of Cambodia cotton seed. During last year a small area was planted with this variety at Embilipitiya, and the results were so encouraging that further experiments are being undertaken in the present season.

There is a local market for the cotton crop, the Ceylon Spinning and Weaving Mills being capable of absorbing all the cotton that Ceylon can produce. This undertaking has co-operated with the Department of Agriculture in the distribution of cotton seed during the last few years, and now contemplates cotton cultivation on a large scale on its own account in order to give practical encouragement to the industry.

FORESTRY AND FOREST PRODUCTS

Forestry in New South Wales.—*The Annual Report of the Forestry Commission of New South Wales for the year ended June* 30, 1921, records an import of timber, mainly softwood, of a value exceeding £2,000,000, more than a quarter of which was white pine and rimu from New Zealand. The area of State forests had been increased by 112,774 acres during the year, bringing the total to over 5,000,000 acres, or nearly half of the total estimated area of forest in the State. Twenty-five forest nurseries were established, and upwards of 1,000 acres were planted with conifers at a cost of less than £3 per acre. Mr. E. H. Wilson after visiting the State urged the need for educating public opinion as to the importance of forestry, the establishment of a school of forestry, the planting of conifers and the prevention of forest fires. Towards the first of these aims the Commission organised an extensive Forestry Exhibit at three Agricultural Shows. A start has been made with a training school at Narara, which is apparently intended to be the school for the whole Commonwealth agreed upon by the Premiers' Conference in May 1920. As to afforestation, however, the Commission report that "much more liberal appropriations will be necessary if the future demand for softwood timber is to be met by planting." Experiments undertaken at the instance of the Commission by the Forest Products Laboratory at Perth, Western Australia, into the pulping qualities of

three species of *Eucalyptus* (*E. maculata*, *E. rubida* and *E. pilularis*) showed them to be difficult to cook and to yield very dark pulps impossible to bleach commercially.

Forestry in Victoria.—In the past the forests of Victoria have been several times transferred from the control of one department to another. The present Forests Commission was appointed as from October 1919, and has issued its *First Annual Report*. A minimum revenue of £40,000 a year has been assigned to it. Whilst at the Premiers' Conference of 1920 a reservation of 24,500,000 acres of forest land was decided on as needed for Australia as a whole, of which 5,500,000 acres of merchantable forest was the quota required in Victoria, a total of little more than 4,000,000 acres, including much land that is inaccessible, is at present reserved in that State. Victoria has hitherto imported much timber from the United States, Canada, New Zealand and the Baltic; but the *Report* points out that these supplies will not be so easily obtainable in the future. As the existing reservations amount to less than 8 per cent. of the area of the State, further reservations are stated to be imperative, including especially the areas occupied by "ironbark" and "grey box." The botanical identity of these trees is not given, but presumably the first vernacular name refers to *Eucalyptus sideroxylon*, A. Cunn., the second to *E. hemiphloia*, F. v. M., and *E. Bosistoana*, F. v. M., these being stated to be the most valuable timbers in the State for sleepers, piles, beams and telegraph poles. The natural regeneration of these valuable hardwoods has been mainly checked by "the ubiquitous rabbit," though wombats do some damage by barking mature trees at the roots. Termites mostly attack trees injured by fire. The species chiefly employed in plantations have been *Pinus insignis*, *P. Laricio*, *P. ponderosa* and *P. maritima*. The small Forest School at Creswick gives an elementary training to a dozen cadets, but the establishment of a single more thoroughly equipped central school and of a forest products laboratory for the whole Commonwealth is recommended. The first year's working of the Commission shows a profit of over £24,000.

Forestry in New Zealand.—New Zealand, so far as State Forestry is concerned, is in a somewhat similar position to Victoria, a newly organised Forest Service having been recently appointed to administer the State forests, which at present comprise 6,800,000 acres, or over 10 per cent. of the area of the Dominion, and a definite

forest policy having been formulated. The latter includes five main points: (1) the permanent dedication to forest management of all Crown forested areas chiefly valuable for forestry, and the deletion from State forests of all lands chiefly valuable for agriculture; (2) the placing of all State forests on a scientific sustained-cut basis; (3) the establishment of protection forests at head-waters; (4) the establishment of a school of forestry; and (5) the promotion of forest research. The *Report for the year ended March* 31, 1921, states that "there are several hundred thousand acres of Crown forest still unsubjected to competent forest administration," and concludes by reiterating the warning that a system of fire-control is the most obvious need. The chief export is that of white pine (*Podocarpus dacrydioides*, A. Rich.) to Australia; and many of the minor native timbers are becoming known as suitable for carriage-building, handles, etc. A considerable number of seedlings for replanting have been successfully raised, chiefly of *Pinus radiata*, *Cupressus Lawsoniana* and *C. macrocarpa*. Thirteen species of *Eucalyptus* gave undersized seedlings and Douglas fir seed gave only one-fifth the proportion of plants obtained in the previous year. Satisfactory experiments have been carried out in the broadcast sowing of *Pinus insignis* and the sowing of *P. radiata* by means of a drill. The Forest Service has been fortunate in securing the co-operation of Canterbury and Auckland Colleges in carrying out by graduates definite forest research into the life history and conditions of growth of various timber species. The *Report* also records the acquisition on exceptionally favourable terms of 900 acres of old Kauri forest near Dargaville, an interesting "vestigial souvenir" of past conditions. A central depository for forest-maps, known as the Forest Atlas, and a forest library have been begun at Wellington. The *Report* also contains the following fitting tribute to the late Sir David Hutchins: "This great master of silviculture and forestry in general passed away during the year in Wellington after a brief illness. His life was full of achievement, and he has left behind him a monument which will stand for all time. This memorial is not built of stone, but of something more lasting and useful in the record of achievements and knowledge of nature, which has contributed to man's progress and the betterment of civilisation. Sir David deserved well of humanity."

Forestry in British Columbia.—The *Report of the Forest Branch of the Department of Lands, British Columbia, for*

1920, contains much interesting matter relating to publicity and fire and insect control, together with some remarkable figures as to production. The export of manufactured lumber from British Columbia in 1920 exceeded 146,500,000 board-feet, an increase of 37,000,000 feet over the record shipments of 1919, Australia alone taking over 32,000,000 feet, as against 8,500,000 in the previous year. The outputs of both pulp and paper show an increase in volume and in value. The total value of the forest products of British Columbia for 1920 was over 92,500,000 dollars, as against 70,250,000 for 1919. Considerable efforts have been made by the Forest Branch to familiarise Toronto and London with British Columbian timbers. This subject has also received the attention of the Imperial Institute Advisory Committee on Timbers (see p. 12). The total loss by fire for the year is estimated at nearly a million dollars, and the attention of schools and newspapers throughout the Province has been drawn to the importance of precautions against forest fires. The two species of pine-bark beetle, *Dendroctonus brevicornis* and *D. monticola*, are stated to have destroyed in about six years, in one area alone, 150,000,000 feet of the timber of the western yellow pine (*Pinus ponderosa*). As many as 2,000 pairs of these beetles have been found in one tree, and the same species of pine suffers from the pest in Oregon, where the tree covers some 14,000,000 acres, and the loss in the season 1919–20 was estimated at 200,000 dollars. The method of control adopted by the Division of Entomology of the British Columbia Department of Agriculture has been to secure the logging of infected trees during March, April or May, when the eggs are unhatched, the slabs with the bark and the "slash" or top and lop being burnt. A *Bulletin* published by the Oregon College Experiment Station in June 1920 enumerates various natural enemies of the beetle, and concludes that control work, such as that above described, should be carried out between September 15 and April 15. The British Columbia Forest Branch has also undertaken some interesting growth studies which, as the *Report* points out, are essential to provide data for forest valuation or management. Hemlock and balsam are being more used for pulp than formerly, and the consumption of Sitka spruce is falling to normal after the heavy war-time demand for aeroplanes. The usual river-bottom habitat of the last species is described as sand overlaying gravel or boulder-clay, liable to flooding by freshets and with little very fine soil, and producing alder and poplar in addition to the spruce.

Tanning Materials

Wattle Bark.—The tanning value of Southern India wattle barks (*Acacia decurrens*) has been investigated by K. C. Srinivasan, M.A., Consulting Chemist, Dept. of Industries, Madras (*Leather Trades Review*, 1922, **55**, 178).

The following analyses of a few samples of air-dried bark from full-grown trees show that South Indian wattles compare very favourably with those of other countries.

	Tannins. *per cent.*	Non-tannins. *per cent.*
South India (Nilghiris) . .	39·3 to 42·1	7·3 to 10·3
South India (High Ranges) .	40·1 „ 44·1	7·1 „ 13·0
Natal	35·2 „ 39·8	7·3 „ 10·3
Cape	40·1 „ 44·1	7·1 „ 13·0
East Africa	36·7 „ 42·1	9·4 „ 12·7
Australia	38·3 „ 49·5	4·4 „ 9·4

Experiments showed that the most suitable temperature for preparing the extract was about 60° C.; at this temperature the proportion of soluble non-tannins to tannins was the smallest, and most of the tannin was extracted.

In order to ascertain the effect of age on the amount of tannin in the bark, the author has examined the bark from branches of trees of different ages in the High Ranges, and has obtained the following results, which show that not only does the amount of tannin increase with age, but the proportion of soluble non-tannins decreases. It was also found that the thicker bark was the richer in tannin.

Age of bark in years .		1	2	3	4	5
Tannins . .	*per cent.*	18·4	24·4	26·0	27·6	29·1
Soluble non-tannins	„ „	17·2	15·2	14·7	11·7	8·0
Insoluble material	„ „	55·8	51·5	49·9	52·9	54·9
Moisture . .	„ „	8·6	8·9	9·4	7·8	8·0

The leather produced with Southern Indian wattle bark appears to be identical in character with that furnished by wattle tannages generally.

MINERALS

IMPERIAL INSTITUTE MONOGRAPHS ON MINERAL RESOURCES: SUPPLEMENTARY INFORMATION. CHROMIUM ORE. COAL. LEAD ORES.

The Monographs on Mineral Resources, which are being issued under the direction of the Mineral Resources Committee of the Imperial Institute, afford information respecting the principal mineral deposits of the world

together with descriptive maps and diagrams, special attention being given to deposits in the British Empire.

The Monographs already issued are as follows:

Chromium Ore, Coal, Lead Ores, Manganese Ores, Oil Shales, Petroleum, Platinum Metals, Potash, Silver Ores, Tin Ores, and Tungsten Ores.

The following pages contain a summary of recent information which has been collected from various sources in order to supplement the contents of the first three of these Monographs.

Similar additional particulars relating to the subjects of other Monographs will be given in succeeding numbers of this BULLETIN.

CHROMIUM ORE

The world's consumption of chromite in 1921 was less than two-thirds that of 1920 owing almost entirely to the depression of the steel-making industry. Many mines, started during the war in the United States, Canada and Cuba, have been either closed down or abandoned. In Cuba there was no production in 1921, whilst the outputs of other countries were very much reduced.

Recently chromium has been used in structural steel to reduce its tendency to rust, and the employment of chromite as a refractory, especially in furnace lining, is being resumed in place of magnesite, which was temporarily used during the war.

Southern Rhodesia.—The chromite deposits of the Great Dyke in the Lomagundi district of Southern Rhodesia have been briefly referred to in the *Monograph* (p. 22), and a description of these taken from the *Report of the Southern Rhodesia Geological Survey for* 1920 has been given in this BULLETIN (1921, **19**, 402). The *Report* confirms the previous statements as to the large extent of the deposits and shows that the ore is of higher grade than was formerly supposed.

Canada.—In the *Final Report of the Munitions Resources Commission of Canada* is given the result of an examination of a chromite deposit six miles from Ashcroft, British Columbia. The deposit outcrops in a small gully, and chromite is found *in situ* all along the gully and large boulders of the mineral are scattered over the surface. The extent of the deposit is unknown, but it is believed to be considerable. The country rock is a serpentine apparently derived from peridotite. Tests made at the Mines Department Laboratories indicate that the ore

could be dressed to produce a concentrate carrying 48 per cent. of chromic oxide.

In *Memoir* No. 118 (1920), *Canada Department of Mines* (pp. 86–91), L. Reinecke describes the deposit of chromite near Scottie Creek referred to in the *Monograph* (p. 27). It is situated on Chrome Creek about half a mile north of Scottie Creek and four miles by road from the junction of that creek with Bonaparte River. The chromite is found in dense black, and also yellow-green, altered serpentine, which outcrops on both sides of Chrome Creek. The ore occurs in nodules, lenses and tabular sheets, and is also disseminated in areas not necessarily connected with a core of rich ore. At the date of inspection a few hundred tons of the richest ore had been mined, the best of which contained, on the average, about 40 per cent. of chromic oxide. Assay results of samples from three open cuts gave in one case 42·6 per cent. of chromic oxide and in the other two cases 36·5 per cent. It was not possible to estimate the quantity of chromite in sight, but as the serpentine areas of the district are themselves small and the ore-bodies so far exposed of quite moderate dimensions, it is improbable that the deposit will yield a large output.

Russia.—The Russian division of the Bureau of Foreign and Domestic Commerce in the United States (*U.S. Comm. Rept.*, No. 221, 1920) states that, in addition to the Ural deposits of chromium ore (described in the *Monograph*, p. 39), deposits also exist on the N.E. shore of Lake Goktcha in Russian Armenia, Transcaucasia. The supply is considered to be large. Chromite deposits are reported to occur along the Gazimur River near the Kultuminsk silver-lead mines in the Transbaikal region of Siberia. These deposits are all undeveloped.

Yugo-Slavia.—According to *U.S. Comm. Rept.*, No. 305, 1920, the chrome ore deposits at Dubostica in Bosnia referred to in the *Monograph* (p. 40) were first opened about 1884, at which time a road was built over the mountains to Vares for transporting the ore; but the deposits are now connected with the Sarajevo-Brod main line by a logging railway on which horses and not locomotives are used for haulage. The ore deposits extend from Blatnica, west of the Bosnia River, S.E. to Curista, and are in a belt about six miles wide. During the war an output of about 2,000 tons of ore per month was obtained from these deposits from surface workings. An adit, started by the Austrian Government, is now being continued by the Yugo-Slavian Government.

New Caledonia.—According to H.M. Consul's Report (*Bd. of Trade Journal*, Oct. 15, 1921), heavy shipments of chrome ore from New Caledonia to the United States during 1920 practically exhausted the accumulated stocks of that material, but, on the other hand, overstocked the United States market so that no sales had been made for 1921. The exports of ore in 1917–20 were 41,891, 53,961, 23,548, and 91,891 metric tons respectively. Of the quantity exported in 1920 the United States took 87,228 tons against about 2,000 tons taken by the United Kingdom, the next largest importer of New Caledonian chromite.

Syria.—According to *L'Echo Min. Met.* (Nov. 16, 1919), chromite ore deposits occur in Cilicia and to the north of Antioch. So far these deposits have only been superficially prospected, and their extent is unknown.

French Togoland.—Brief reference was made in the *Monograph* (p. 24) to a chromite deposit situated near the Lome-Atakpame Railway. The results of examination of a deposit at Djeti about 9 miles S.W. of Dadja on this railway are now available in a *Report on the Geology of Western Togoland*, by T. Robertson, published by the Gold Coast Government in 1921, an abstract of which appeared in this BULLETIN (1921, **19**, 403). The deposit appears to occupy quite a small area and is not likely to prove of great economic value. The quantity of chromic oxide in samples taken from five prospecting pits ranged from 36·4 to 41·7 per cent.

Brazil.—In *Eng. and Min. Journ.* (Feb. 26, 1921), H. E. Williams describes the chromite deposits of Santa Luzia, 130 miles N.W. of Bahia, briefly referred to in the *Monograph* (p. 54). They occur about 1½ miles east of Santa Luzia railway station in a country rock of gneiss cut by numerous pegmatite dykes. The deposits are large and the ore is compact and mixed with amphibole.

Much ore was mined and shipped to the United States in 1918 and, in addition, several thousand tons are at surface. Production since the war has practically ceased, but attempts are being made to revive it.

Several other deposits are known in this region which may prove important when further examined.

COAL

The collapse in the coal-mining industry due to the war has been especially noticeable in all European coal-pro-

ducing countries, with the exception of Belgium, which has made a rapid and remarkable recovery. Of some countries there are few records of recent production, even unofficial, but in the others greatly diminished outputs are reported. Compared with those of 1913, the production in 1920 of some countries was reduced by the following percentages: Great Britain, 20; France, 46; Germany, excluding Saar and Alsace, 24, but in this case the production of lignite has been greatly increased. The United States profited greatly by the dearth of coal in Europe, and exported Appalachian coal even to Switzerland and to Austria, and the British bunkering trade in the Far East has been largely taken over by Japanese, Chinese, and East Indian interests.

The huge coal deposits of Alberta mostly await exploitation, the selling of the coal being hindered by the distance of the markets both east and west and by high freight rates. The brown coals of Victoria, Australia, are now being actively developed and will supply fuel in connection with a large power scheme which has been previously referred to in this BULLETIN (1921, **19**, 538). Much development of coal deposits has taken place recently in other parts of the world, especially in China.

The checking of the waste produced by the uncontrolled and unscientific burning of bituminous coal, especially in the big cities, has been the subject of much enquiry, and it is claimed from the results of large scale experiments at the Midland Testing Station, at East Kirkby, that the low temperature distillation of coal is now commercially successful. Much attention has been given to the washing of coal and its better preparation for use, including the elimination of sulphur. The flotation process is now being used to produce a material with low ash content, and is being applied to recovery from waste dumps and from inferior coal. The process produces a coke with great coherence and of high metallurgical value. The use of pulverised coal in boiler plants and in smelter works, especially in the United States, has been greatly increased of late, and much attention has been given to briquetting and other treatment of lignite to facilitate its transport.

General.—The physical composition of banded bituminous coal is a matter of much interest. Its four constituents are now generally recognised as *clarain* (bright coal with plant debris), *vitrain* (structureless bright coal with conchoidal fracture), *durain* (dull hard coal or hard spore coal), and *fusain* ("mother-of-coal," "mineral charcoal," "dant," "suddy parting," "carbonised wood,"

etc.). From a number of seams examined, according to F. S. Sinnatt (*Coll. Guard.*, Dec. 13, 1921, p. 1725) the percentages of the four constituents were found to be as follows: clarain, 52; vitrain, 25; durain, 20; fusain, 1. Whilst the percentage of ash is fairly constant in clarain and vitrain, it is much more varied in durain, and exhibits very considerable discrepancies in fusain (this BULLETIN, 1921, **19**, 91). Clarain, as a rule, has a higher agglutinating value than vitrain, whilst durain is practically deficient in coking qualities.

Grand' Eury originated the name "fusain" in 1876. He described it as "the dull coal which soils the fingers—representing portions of stalks, the anatomical structure of which has disappeared." It is often associated with pyrite. According to the researches of F. S. Sinnatt, H. Stern and F. Bayley (*Bull.* No. 5, 1920, *Lancashire and Cheshire Coal Research Assoc.*), fusain occurs widely in Lancashire coals, but the amount present varies considerably. There appear to be two distinct forms of it: the first is a hard compact variety, occurring rather rarely; the second is in the form of plates, bands or large lumps, and also as a powder distributed over the surface of the coal. Fusain is a jet-black powder, has a needle-like structure, ignites with considerable ease at a low temperature, and continues to smoulder at a dull red heat without the production of smoke or flame, and with only a faint odour, which is aromatic. The analysis of samples of fusain from seven different coals showed that the ash is frequently very much higher than that from average coal, and that the proportion of volatile matter is always lower and the percentage of oxygen very low. It "would appear that the fusain was passing into the anthracite stage, with only a small proportion of compounds of the type of ordinary bituminous coal in its composition" (F. S. Sinnatt, *Manchester Geol. and Min. Soc.*, Oct. 12, 1921).

Various samples of mine dust yielded from 16 to 38 per cent. of fusain. The authors of the Lancashire and Cheshire Coal Research Association's *Bulletin* No. 5 (already quoted) conclude that "the presence of fusain in the dust in the goaf and in mines generally may have a marked influence on the tendency any particular seam has to produce gob fires and for the zone of combustion to spread."

Reinhardt Thiessen, who has made a microscopic study of American coals, states that there appears to be no corresponding class to vitrain in that country, and he divides banded bituminous coal into two classes only: bright coal or *anthraxylon*, and dull coal or *attritus* (*Coal*

Mining Inst. of America, Pittsburg, Dec. 9, 1920; *Canad. Min. Journ.*, 1921, **42**, pp. 64, 86, 109 and 124).

Great Britain.—Papers by H. H. Ridsdale dealing with the extent of the South Staffordshire, Warwickshire, South Derbyshire and Leicestershire coal-fields, and by Wickham King, relating to South Staffordshire only, have already been referred to in this BULLETIN (1921, **19**, 405).

Ireland.—Grenville A. J. Cole's new estimate of the Irish reserves of coal as about 222 million long tons has been referred to in this BULLETIN (1921, **19**, 90).

Federated Malay States.—The output from the Selangor coal-field, referred to in the *Monograph* (p. 40), has continued to increase, amounting in 1920 to 247,917 tons. Hydraulic sand stowage was successfully carried out in 1920 (*Suppt. F.M.S. Govt. Gaz.*, June 17, 1921). The dry coal contains the following percentages: carbon, 67·9; hydrogen, 4·7; nitrogen, 1·4; sulphur, 0·4; oxygen, 19·6; ash, 6·0. The gross calorific value (dry) is about 6,100 calories, and when carbonised at 900° C. the coal yields about 43·75 per cent. of volatile matter (W. A. Bone, *Journ. Roy. Soc. Arts*, March 31, 1922).

India.—Further particulars of the deposits of tertiary coal in Hsipau State of Northern Shan States, Burma, referred to in the *Monograph* (p. 66, footnote) are given by Edel Modenke in "Mining and Metallurgy" (*Am. Inst. Min. and Met. Eng.*, No. 175, July 1921, pp. 30–31). According to this author there are two beds: an upper one, averaging 12 ft., and a lower one, 21 ft. in thickness, separated by 21 ft. of sandstones and shales. The deposit was opened up in 1919 by a double-track slope to a depth of 500 ft., which was afterwards extended to 750 ft. Modenke considers there are 50 million tons of coal in the lower and 30 million tons in the upper bed, this being a very conservative estimate of the contents of the proved portion of the basin.

Nigeria.—An account of recent developments at the Udi Colliery was given by Sir F. D. Lugard in his *Rept. on the Amalgamation of Northern and Southern Nigeria, and the Administration*, 1912–19, and a summary of the information contained therein was published in this BULLETIN (1920, **18**, 281).

The reserves of coal in the comparatively small area

developed by the Government are estimated at 12 million tons. The output at the time of the report was over 500 tons a day, with a maximum of 768 tons, whilst it was estimated that, in 1919, 200,000 tons were produced.

Canada.—The Saskatchewan reserves of tertiary coal are estimated to amount to 59,812 million tons, and an investigation recently made by W. A. Bone (*Journ. Roy. Soc. Arts*, March 31, 1922) of four representative samples from the Souris Valley showed them to be of a laminated lignite class, containing in the raw state between 30 and 40 per cent. of water, which, however, could be reduced to about 18 per cent. by "air-drying." The completely dried coals showed the following ranges of percentage composition: carbon, 61·6 to 64·5; hydrogen, 4·2 to 4·7; sulphur, 0·6 to 0·9; nitrogen, 0·6 to 1·0; oxygen, 20·5 to 24·7; ash, 6·1 to 11·2. The gross calorific value ranged from 5,650 to 5,900 calories.

With reference to the development of lignite in Canada, referred to in the *Monograph* (p. 103), it is interesting to note that the Dominion Government has set up a Lignite Utilisation Research Board provided with funds to carry out researches and investigations. The results of preliminary investigations by E. Stansfield, R. E. Gilmore and others have already been published (*Canada, Summ. Rept. Mines Branch. Dept. Mines for* 1918 (1920), pp. 87–105). Coal from the Shand mine, near Esteven, Saskatchewan, was selected for experiment, and the conclusion arrived at was that the most hopeful treatment for the Souris lignite is low temperature carbonisation, followed by the briquetting of the residue with the addition of a binder. In the case of bituminous coal it might be noted for comparison that it has been long known that the most economical treatment is a preliminary carbonisation with recovery of by-products. The report gives the results of a large number of small and large scale laboratory experiments, exhibited both in tabular and graphic form.

Australia.—*New South Wales.*—The Coorabin brown-coal field, in Urana Co., New South Wales, has been reported on by L. J. Jones (*New South Wales, Ann. Rept. Dept. Mines for* 1920, pp. 113–119). Since the date of J. E. Carne's inspection (1916), the coal-seam discovered there has been proved by bore-holes to be from 8 ft. 3 in. (northern end) to 36 ft. (southern end) in thickness, including a few thin partings. The calorific value of the seam at No. 4 bore, where it is 36 ft. thick, is 5,443 calories, with an average ash percentage of 14·85. The quality of this coal

compares very favourably with that of the coals from Morwell (Victoria), Leigh's Creek (South Australia) and Collie (Western Australia).

Queensland.—The geology of the Walloon-Rosewood coal-field, referred to in the *Monograph* (p. 120), has been recently described by J. H. Reid (*Queensland Govt. Min. Journ.*, 1921, **22**, pp. 223, 264, 310 and 357). The coal-field is in an area from 6 to 12 miles S.W. of Ipswich. Six small collieries were in operation at the end of 1920. The Caledonian, at Thagoona, is the largest and best-equipped colliery on the field. The coal is a long-flame gas coal belonging to the bituminous class. Most of the seams are thin, badly banded and lenticular. They appear to be confined to the Rosewood beds of the Walloon Series, which are composed mainly of soft felspathic sandstones with clay shales. The average dip is about 2° towards S. 10° W. (or varies from 150 to 250 ft. to the mile). The seams worked vary from 2 to 6 ft. in thickness, and as a rule not much more than 3 to 4 ft. of coal is obtained in any particular seam. The production from 1913 to 1920 inclusive amounted to about 309,000 tons. Owing to the extremely lenticular shape of the seams, and to the absence of any deep mines or prospecting works, no useful estimate can be made of the reserves.

According to W. E. Cameron (*Queensland Ann. Rept. Under-Secy. for Mines for* 1918, pp. 200–201), bore-holes put down recently at Baralaba, Dawson River, prove that the main seam of coal lies in a trough some 15 chains in width with a steep limb on the S.W. and a flatter limb on the N.E. There are about 800,000 tons of coal here at depths nowhere exceeding 400 ft., of which at least 500,000 tons should be available. There is possibly another trough of coal lying to the S.W. of bore No. 15.

South Australia.—Several Government bores were put down recently in Hope Valley, South Australia, in order to test the lignite in the Hundred of Yatala (cf. *Monograph*, p. 123). Some of the bore-holes were unsuccessful, but others met with lignite. No. 4 bore passed through two seams 11 and 18 ft. in thickness, separated by 14 ft. of lignitic clay. In No. 5 bore were two seams, 11 and 6 ft. thick, separated by 29 ft. of lignitic clay. In No. 7 bore there were also two seams, 12½ and 19 ft. thick, separated by 14 ft. of lignitic clay; and in No. 11 bore two seams 16 and 12 ft. thick, separated by 11 ft. of lignitic clay (*South Australia Dept. Mines, Min. Rev.*, No. 33, 1921, p. 25). Bore No. 4, put down later, passed through lignite 7 ft. thick. The drilling plant was then removed to the Hundred of Clinton, where a bore was put down and entered lignite

at a depth of 222 ft., which was 26 ft. thick; lower down three other seams were cut, 10¾ ft., 19 ft. and 12 ft. thick, the intervening lignitic clay being 16½, 2¾ and 15 ft. thick respectively: the total thickness of lignite passed through amounted to 67¾ ft. (*Min. Rev.*, No. 34, 1921, pp. 27–31).

According to L. J. Winton (*Min. Rev.*, No. 33, 1921, pp. 66–78), the lignite of the Hundreds of Sherlock and Seymour is of Miocene age. In the Hundred of Seymour, borings have proved beds of lignite from 5 to 20 ft. thick. In the Hundred of Sherlock, where the greatest work has been done, several bore-holes have been put down showing seams from 6 in. to 45 ft. in thickness. The lignite appears to occur as a series of basin-like deposits, which thin out towards the edge of the basin. The reserves on the Murray Company's block, taking the thickness as 25 ft., are 4 million tons.

No. 10 bore, put down later at Moorlands (Hundred of Sherlock), showed a main seam 14½ ft. thick; No. 11 proved one of 27 ft., and No. 12 passed through three seams 12, 19½ and 2 ft. thick (*Min. Rev.*, No. 34, 1921, p. 32).

The most promising scheme for utilising this fuel seems to be the generation of power at a suitable place, as close as possible to the source of supply. If converted into electrical energy the power could be distributed over a considerable area, including Adelaide itself (*Min. Rev.*, No. 33, 1921, p. 77).

Recent borings have indicated that the more southerly of the basins of the two coal measures of Leigh's Creek coal-field (Jurassic) does not carry any workable seam of coal, while the more northerly basin has been found to carry a thick seam far beyond the limits of the area previously tested. The Leigh Creek Coal Committee, appointed in 1917, recommended the erection of a small pulverising plant, in order to make full experiments on a working scale with the coal in powdered form in locomotives on the northern railway (*Min. Rev.*, No. 31, 1919 (1920), pp. 41–42).

Victoria.—According to W. A. Bone (*Journ. Roy. Soc. Arts*, March 31, 1922), the brown coal of the state mine at Morwell, Victoria, when dried has the following percentage composition: carbon, 62·5; hydrogen, 4·85; nitrogen, 0·45; sulphur, 0·20; oxygen, 28; ash, 4. The gross calorific value is 5,600 calories. Large-scale steam trials are now in progress, and a large electric power station scheme at Morwell is being carried out. It is anticipated that, a few years hence, the city of Melbourne will derive the whole of its electric power from Morwell

coal, and the Victorian State Railways will be worked electrically by energy generated from the same deposits.

The Victorian Government Electricity Commissioners have installed at Morwell a boiler of the Babcock-Wilson type, fitted with a "fuel improver" designed by the Underfeed Stoker Co., whereby the raw fuel, containing about 50 per cent. of water, is dried and up-graded at the expense of part of the heat of the outgoing products of combustion.

Western Australia.—The following information on progress in Western Australia is published in the *Rept Dept. Mines, Western Australia, for* 1920. A bore-hole put down in the Collie coal-field, Western Australia, in 1920, reached a depth of 1,136 ft. and passed through 8 coal seams, 3 ft. and upwards in thickness. A bore-hole put down at Wilga, about 16 miles south of Collie, to a depth of 598 ft., pierced two seams, 3 and 5 ft. in thickness. Boring operations on the Irwin River, about 20 miles N.E. of Mingenew, are in progress, but so far no seam of workable thickness has been discovered.

New Zealand.—P. G. Morgan has reported on the Tangarakau coal-field, North Taranaki (*New Zealand Journ. Sci. and Technol.*, 1921, **3**, Nos. 5 and 6, pp. 297–301). The seams of brown coal are thin, and transport to the railroad will be expensive; hence it is unlikely that this coal will be able to compete successfully with coals from other districts. Some of the seams, which are several feet thick in places, deserve a certain amount of prospecting.

Lead Ores

According to estimates of the U.S. Geological Survey, the United States production of lead increased from 428,000 short tons in 1919 to 483,000 in 1920, whilst that of the rest of the world increased from 58,000 to 64,000. Increasing demands for lead products have been made, in order of importance, by the paint industry for lead pigments, by the makers of electrical storage batteries, and by the manufacturers of lead-encased cable. Most of the lead-consuming countries are still unable to purchase all the lead they require owing to present market prices, but Germany has been buying heavily. Prices have, however, been considerably reduced, although the cost of production remains high on account of high cost of materials and wages.

Much scrap lead has been recovered from war material and resmelted.

The use of the flotation process for the separation of lead from zinc minerals has become general, and the present success of the lead industry is attributable very largely to this fact.

The long protracted strike at Broken Hill seriously lessened the lead output of Australia. The lead mining industry in Spain was similarly affected. A report of the Ministerio de Fomento refers to the general impoverishment of the mines; the exorbitant rents paid by working concerns; the high prices of materials, and the insufficiency of hydro-electric power, as the principal causes of depresión in Cartagena.

The Burma Corporation is contemplating the erection of a modern metallurgical plant to replace an old one, now out of date, near its mines at Nam Tu; its production capacity will be 60,000 tons of lead and 5 million oz. of silver per year. A new concentrating mill with a capacity of 800 to 1,000 tons per day was started in August 1920. A hydro-electric plant has been erected at Mansam. The erection of a zinc-smelting plant and of a sulphuric acid plant at Jamshadpur to treat 25,000 tons of concentrate per annum is being considered.

Great Britain.—In *Min. Journ.* (Jan. 22, 1921), W. H. Paull contributes an account of the lead and zinc mines of Cardiganshire, and shows that a former annual production of about 80,000 tons of lead ore has dwindled to about 20,000 tons at the present time, although there are still abundant reserves of ore which might be developed. In discussing the prospect of successful competition with foreign mines, the author states that the Cardiganshire mines show the existence of well-defined and permanent veins of mineral of a richness only surpassed by the Australian Broken Hill deposits and some of the larger deposits of America. Although many million pounds' worth of ore has been taken from these mines in past years, there is not a single mine which has been worked at a considerable depth. The veins invariably retain their mineral value in depth, and, indeed, tend to improve. The author considers that the prospects of profitably working these mines at greater depths by modern mining and milling methods are very good.

India.—The lead-zinc ores at Bawdwin in the Northern Shan States have been described in the *Monograph* (p. 61), and J. Coggin Brown refers in *Rec. Geol. Survey of India* (1921, **52**, 136) to deposits of lead ore in the Myelat division of the Southern Shan States. The latter deposits are

apparently small, and the production from them in 1917 and 1918 was only 146 and 117 long tons of ore.

A small production of lead ore has also been reported from Drug in the Central Provinces, from Chitaldrug in Mysore, and from Kashmir.

The annual production of lead from the Bawdwin mines is said to be now sufficient to supply the requirements of India and Ceylon, where there is a consumption of 15,000 to 16,000 tons yearly.

Nigeria.—The existence of lead deposits in Nigeria carrying varying amounts of silver has been known for the past twenty years. The ore occurs irregularly in pockets. The deposits are along a line, approximately north to south, and have been traced from the Afikpo district in Southern Nigeria to the Muri province, north of the Benue River, a distance of some 100 miles. The southern area was first investigated in 1903 by the Mineral Survey conducted in connection with the Imperial Institute, the report of the surveyors being unfavourable. Several attempts have since been made to develop the deposits, but hitherto without success.

Union of South Africa.—An abstract of a report in the *South African Journ. Indust.* (1920, **3**, 1058) by Malcolm Fergusson, Inspector of Mines, and Percy A. Wagner, Government Geologist, on the old Doornhoek lead mine, Marico District, Transvaal, has appeared in this BULLETIN (1921, **19**, 108).

In this BULLETIN (1921, **19**, 414) is also an abstract of an article by E. M. Weston in *Chem. Met. and Min. Rev.* of June 5, 1921, which describes the promising character of the argentiferous lead and other deposits near Argent Siding, Transvaal.

Canada.—A copper-lead deposit of an unusual character at Legate Creek, which enters Skeena River one mile west of Pacific on the Grand Trunk Pacific Railway in British Columbia, is described by W. L. Uglow in *Min. and Sci. Press* (Aug. 6, 1921). The deposit is a replacement of what appears to be a bed of tuff and consists of an upper hard silicified portion up to 5 ft. in thickness, carrying disseminated chalcopyrite with some bornite and galena, lying on a lower soft finely crushed portion up to 8 ft. in thickness, consisting chiefly of broken decomposed rock and gouge, containing bornite, galena and chalcopyrite. This lower finely crushed portion rests on a well-defined footwall

in depressions of which solid masses of sulphides occur, which are the main source of the ore. A shipment of 125 tons of ore in 1916–17 realised a net profit of over $100 per ton, and contained 30 per cent. of lead, 18 per cent. of copper and about 18 oz. of silver to the ton. The upper hard portion of the ore zone gave gross values ranging from $6·50 to $60 per ton. A considerable tonnage of ore should be available in this deposit.

The galena and blende deposits in the neighbourhoods of Dorion and McTavish townships, Ontario, have been described by T. L. Tanton in the *Summ. Rept. Geol. Survey of Canada for* 1919, Part E, and an abstract of the account has appeared in this Bulletin (1921, **19**, 243).

The *Monograph* (p. 68) refers briefly to lead-zinc ore occurrences in the Gaspé Peninsula, Quebec, which until quite recently had not been regarded as of great commercial importance. In the later years of the war considerable attention was directed to the mineral deposits of this region, with the result that the above occurrences have been proved to be of large extent and high quality. The deposits are fully described by J. C. Biedelman in the *Canadian Mining Journ.* of Feb. 6, 1920. The ores, consisting of lead and zinc sulphides in approximately equal quantities, usually occur in fissures in slate, the gangue being quartz and dolomite. Development has been confined to the Federal mine, on which 16 veins have been discovered in an area of about 50 acres. These veins, which dip at a high angle, vary in width from 4 to 60 ft., and some have been traced along the strike for upwards of 3,000 ft. Cross-fissuring has resulted in the formation of brecciated mineral zones of great width, which add greatly to the tonnage of ore that can be mined from the fissure veins. The deposits have been separately examined, and reported on favourably, by A. P. Coleman of the Geological Survey of Canada, A. Mailhiot of the École Polytechnique of Montreal, and Walter H. Weed. The district suffers from lack of communications, but this disadvantage is being overcome.

Australia.—According to the *Min. Rev.*, Nos. 32 and 33, *S. Australia, Dept. Mines*, 1920, a discovery of argentiferous lead veins was made in 1920 on a field abandoned about thirty years ago at Eukaby Hill, about 9 miles from Baratta Head Station, South Australia. There are several small veins in slates, but at one point there is a brecciated formation 5 ft. wide, containing lead mineral, and at another a number of small parallel veins over a width of 3 ft. Samples of the ore have shown high lead

content, and silver ranging from 27 oz. to 46 oz. per ton. The deposits are being actively prospected.

In *Chem. Eng. and Min. Rev.* (December 1920), a brief description is given of the lead mines near Ajana in the Northampton district of Western Australia (cf. *Monograph*, p. 72). The lodes are in an area of low-lying hills. They are numerous and appear to have no general strike, some trending N.–S., others N.E.–S.W., and others N.W.–S.E. The Surprise mine at Geraldine, the principal mine of the district, has been opened on a lode 15 to 20 ft. wide, of which 8 to 12 ft. is sometimes composed of clean galena, which can be mined and shipped without milling. For lower grade material a dressing plant has been installed, and in 1919, 3,000 tons of concentrate assaying 70 per cent. of lead was obtained. The Ajana lead mine is on the same line of reef and contains a shoot of ore 15 to 18 ft. wide, which has been proved for a length of 180 ft. and assays 15 per cent. of lead. This appears to be a valuable body of ore, and a dressing plant is being installed. There are numerous other prospects in the same locality, some of which are being developed with satisfactory results.

China.—In this BULLETIN (1921, **19**, 99) has appeared an abstract of an article by J. Coggin Brown (*Mem. Geol. Survey, India*, 1920, **47**, 124) on the argentiferous galena deposits in the province of Yunnan, not far from the Burmese frontier.

Russia-in-Asia.—The *Min. and Sci. Press* (Sept. 6, 1919) contains an article by Chester W. Purington on Siberian mines and mining, in which reference is made to the great importance of the lead-zinc-silver deposits of West Altai. Little has been published regarding the geological conditions under which these deposits occur, but there is no reason to suppose that they are different in type from those usually associated with similar deposits. The principal mineral property in the region is the Ridderski Kope about 50 miles N.E. of Ust-Kamenogorsk on the Irtysh River. On it a huge ore-body exists in which, it is reported, 945,000 tons of ore have been developed, averaging 18·1 per cent. of lead, 31·2 per cent. of zinc, and 9·7 oz. of silver to the ton, as well as about 2,250,000 tons of lower grade material termed "concentrating ore." No production has yet taken place, although the mine is well equipped for producing on a very large scale. This awaits more settled political conditions in Russia.

The Nerchinsk mining region has yielded silver ores for many years, but no serious attempt appears to have

been made to work the rich lead-zinc ores in the same deposits.

At Te-Hu-He, in the coast region of Siberia, rich zinc ore has been mined and shipped in recent years, but less attention has been given to the lead minerals found in association with the zinc ores.

Spain.—A description of the lead and zinc ore deposits in the Sierra de Nerja, Málaga, Spain, has been given in this BULLETIN (1921, **19**, 244).

Turkey-in-Asia (Anatolia).—Lead ores usually associated with zinc and silver minerals are known to occur in many parts of Anatolia.

In *Peace Handbook* No. 59 (pp. 88–99) it is stated that a German report on mining in Anatolia refers to the successful results of working argentiferous lead ore at Berektli Maden, some 37 miles N.E. of Bulgar Maden, but supplies no particulars. The *Handbook* also gives the following information: At Karasu in the sanjak of Ismid, the Société Minière Anonyme Ottomane de Karassou has worked argentiferous lead-zinc ores since 1898 with varying success. Near the Asiatic shore of the Dardanelles, about 10 miles S.W. of Lapsaki, an English company was developing a mine prior to the war, and in the vilayet of Kastamuni there are abandoned workings of silver-lead ores, which might be successfully worked if better transport were available. During the war the Turkish Government granted many concessions for working silver-lead ores in Anatolia.

Yugo-Slavia.—Particulars of the lead and zinc mines of Yugo-Slavia, taken from the *Report on the Geology and Mineral Resources of the Serb-Croat-Slovene State* by D. A. Wray of the Geological Survey of Great Britain have been given in this BULLETIN (1921, **19**, 414). The information includes a description of the Misitsa lead mines in Northern Slovenia, the Srebrenitsa lead and silver mines in Eastern Bosnia, the Kucajna lead and zinc mines in North-East Serbia, and the Kratovo lead mines of Macedonia.

Madagascar.—According to *Bulletin Économique de Madagascar* (1920, p. 21), lead ore deposits exist in Madagascar at Ankitokazo, in the Ambilobe district; at Bekiady; at Ambatofangehana, near the Pachoud copper mine; and at Kalempobe in the north of the island of Nossy-Be. These deposits have not yet been worked.

Guatemala.—According to Ben T. Wells in an article on Mining in Guatemala (*Eng. and Min. Journ.*, March 12, 1920), lead ore deposits are found in various parts of the Republic and sufficient lead is obtained from them for local use. In the north-western part there is probably one of the largest unworked lead ore deposits on the American continent. At present it is too remote to be profitably developed, but as soon as transport facilities are available a large production may be anticipated.

Mexico.—Although for a number of years Mexico has been one of the larger producers of lead ore, published information about the deposits of the country has hitherto been somewhat scanty. In *Min. and Sci. Press* (Aug. 27, 1921), R. B. Brinsmade gives a descriptive article on the lead ore deposits near Zimapan, Hidalgo, from which the following information has been taken.

The ore deposits occur along a lime-porphyry contact extending from Actopan in the south in a N.W. direction through Cardonal, Pachuca, Bonanza, Monte, Balcones, Ortiga and Las Canas. The nearest railway point is 30 miles to the south at Ixmiquilpan, and is connected with the mines by only a poor cart-road. The chief local sedimentary rocks are limestones and marl sharply folded; these are penetrated by acid intrusive rocks. Wherever the intrusives have penetrated rocks favourable to deposition, the contact is marked by ore-bodies of lead, silver, copper and gold, but chiefly of the first two metals. These ore-bodies are generally found in the sediments at or near their contact in the form of chimneys or lenses, but they also occur along fissures as quartz veins. The ore minerals appear to vary partly with the nature of the matrix, partly with local variations in the porphyry, and partly with depth below the surface. The oxidation zone extends to considerable depths, and secondary enrichment of silver and copper minerals is common. Some of the deposits have been worked out, but several mines are working at the present time with a noteworthy aggregate production.

NOTICES OF RECENT LITERATURE

Applied Entomology: an Introductory Text-book of Insects in their Relations to Man. By H. T. Fernald, Ph.D., Professor of Entomology, Massachusetts Agricultural College, and Entomologist of the Massachusetts Agricultural Experiment Station. Pp. xiv + 386, 8vo, 9×6. (New York and London: McGraw-Hill Book Company, Inc., 1921.) Price 21s.

This volume is intended as a college textbook for an introductory course either for agricultural students who want merely a general knowledge of insects or for those proposing afterwards to specialise in entomology. After a brief account of the external structure of insects, and still shorter descriptions of their internal structure and methods of development, several chapters are devoted to insecticides; but five-sixths of the work is occupied by general descriptions of the structure, habits and economically important examples of the twenty-four orders into which insects are now divided. Though these examples are American, there is much in the volume that might prove of great use to the cultivator in the Old World. The work seems to have been most carefully and accurately carried out and is illustrated by nearly four hundred first-rate figures. It is well printed on heavy glazed paper and sensibly bound in buckram.

Insect Pests of Farm, Garden and Orchard. By E. Dwight Sanderson. Second Edition, revised and enlarged by Leonard Marion Peairs, Professor of Entomology, West Virginia University. Pp. vi + 707, 8vo, 8×5¼. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1921.) Price 26s.

In a very frank preface to the first edition of this work the author acknowledged that it was practically confined to the insect pests of the United States east of the Rockies, and did not include those affecting citrus fruits. The latter omission has been rectified by the inclusion of a special chapter by the editor of the present issue, who has also added chapters on insects injurious to man, his household and his domestic animals. The importance of its subject is justified in the opening chapter of the book by some astounding figures which put the annual losses of farm crops in the United States through insect pests at 1,866 million dollars, in addition to 100 million lost on forest

products and 300 million on products in storage. As the body of the work is practically a book of reference for the cultivator, arranged under about a score of the principal farm, garden and orchard crops, much on the lines adopted by Miss Ormerod in her well-known manual for this country, and the introductory chapter on the structure of insects is of the slightest, we would suggest that it would be well if agriculturists in America before attempting to use it for reference were to work through Prof. Fernald's book noticed above. Maps of the distribution of the pests in the United States are given and several of the diagrammatic warning notices issued by the Agricultural Department are reproduced and will doubtless be conveniently accessible in this form. There are upwards of 600 figures, but those reproduced from photographs are certainly less instructive as to structure than the more diagrammatic drawings. It is regrettable that actual scales of magnification are not given in all cases.

The Textile Recorder Year Book, 1922. Compiled and edited by Frank Nasmith. Pp. lxv + 662, 8vo, $7\frac{1}{2} \times 5$. (Manchester: John Heywood, Ltd., 1922.) Price 7*s.* 6*d.*

This book gives a comprehensive survey of the textile industries involving the use of cotton, wool, silk (both natural and artificial), flax, jute and ramie, and deals with all the various activities concerned in the production and manufacture of these materials. It is intended principally for the textile worker, and is written in a practical manner, certain sections having been specially prepared by well-known experts.

The work contains a vast amount of information which is set out clearly and concisely with the aid of numerous tables and diagrams. In the case of cotton, for example, there are given statistics of production and consumption in all the principal countries of the world, tables of prices of various classes of cotton from 1770 to 1920–21, data regarding the times of planting and picking of cotton in the United States, length of staple of the cotton grown in the different States, particulars of the size, weight and methods of packing American, Egyptian and Indian bales, the methods of buying and selling with special reference to the Liverpool market, information relating to contracts, definitions of cotton market terms, a glossary of cotton fabrics, and accounts of the various processes of manufacture, including preparation, spinning, doubling, twisting, gassing, sizing, weaving, bleaching, dyeing, finishing and mercerising.

There are also sections relating to fuel consumption and economy, boilers, engines, transmission gearing, millwrighting, etc.; to methods of humidification, lighting, heating and arrangement of machinery in the mills; and to hours of labour, wages, mill insurance and many other matters, too numerous to mention, including a directory of textile companies.

The work thus forms a useful book of reference for textile workers generally.

Artificial Silk and its Manufacture. By Joseph Foltzer, Fabrique de Soie et de Cuir Artificiels, Riedikon-Uster, Switzerland. Translated from the French by T. Woodhouse, Head of the Weaving and Designing Department, Dundee Technical College. Pp. xi + 244, 8vo, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Sir Isaac Pitman & Sons, Ltd., 1921.) Price 21s.

This volume contains practically the whole of the second French Edition (1909) together with many new particulars and drawings relating to improvements which have been introduced since the publication of the latter. This additional matter was supplied by M. Foltzer, who has had a wide experience of the artificial silk industry.

After a discussion of the nature and reactions of the different celluloses, including an account of the changes which occur during the process of mercerisation, a description is given of the following kinds of artificial silk and the methods of manufacturing them: (1) the artificial silk of Chardonnet, made from nitrocellulose; (2) the Despeissis artificial silk, formed from a solution of cellulose in ammoniacal copper oxide; (3) Cross and Bevan's viscose, or artificial silk made from cellulose thiocarbonate; and (4) the lustrous artificial silk made from a solution of cellulose in zinc chloride.

The various processes involved in the manufacture of artificial silk yarns are well described with the aid of numerous illustrations and diagrams, and notes are added on the establishment, organisation and equipment of an artificial silk mill. The last two chapters deal with the dyeing of artificial silk and the conversion of cellulose products into thread, ribbons, felt, artificial hair and leather, and various other materials.

The book will be of value not only to those actually engaged in the artificial silk industry, but also to students and others interested in the subject. Its usefulness is somewhat diminished, however, by the fact that only a

very meagre index is provided, and this point might well receive attention when the issue of a new edition is contemplated.

Wool Substitutes. By Roberts Beaumont, M.Sc., M.Inst.Mech.E. Pp. xiv + 190, 8vo, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Sir Isaac Pitman & Sons, Ltd., 1922.) Price 10*s*. 6*d*.

The term "wool substitutes" is rather a misnomer, as the products comprised under this term are not fibres, either natural or artificial, which can be used in place of wool, but consist of wool itself, and include the waste produced in the manufacture of woollen or worsted goods, and the wool recovered or "reclaimed" from rags and cast-off clothing. There is no such thing as a true wool substitute, for, although attempts have been made to impart some of the properties of wool to certain vegetable fibres, particularly those of the jute class, the resulting material necessarily retains its original structure, which is, of course, quite different from that of wool.

The "wool substitutes" dealt with in this book include the following products: (1) Mungos, which are obtained by the disintegration of old or new rags of a milled or firm structure. (2) Shoddies, which consist of longer fibre than mungos, being obtained from materials of a looser structure, either knitted or woven. Mungos and shoddies are each classed in two categories, according as they are derived from "new" or "worn" cloths. (3) Extract wool, which is obtained from union goods, *i.e.* cloths of woollen or worsted fabrics, partially composed of cotton. The preparation of the "extract" involves the decomposition of the vegetable fibre and the recovery of the wool. (4) Noils, consisting of the short fibres, obtained in the operation of wool-combing, which are rejected as unsuitable for the production of worsted yarns. (5) Waste obtained in the mill during the operations of carding and spinning. (6) Waste from the processes of warping, healding and weaving. (7) Flocks from the processes of scouring, milling and cutting. All these products are described, and an account is given of the methods, machinery and appliances employed in their manufacture into textiles.

The importance of the "wool substitute" industries may be gauged from the fact that about two-fifths of the total weight of wool fibre employed in this country for the production of textiles consists of these waste or reclaimed materials.

The book is well and interestingly written, and contains a large number of useful illustrations and diagrams.

Oil Palms and their Fruit. By Dr. A. A. L. Rutgers, Edmond Leplae, and Paul Tingey. With an Introduction by E. R. Bolton, F.I.C. Pp. vi + 41, 8vo, $7\frac{1}{2} \times 5$. (London: Griffith & Company (Printers), Ltd., 1922.) Price 3s.

This publication contains three papers which were read before the Oil and Cocoa Section, Agricultural Hall Conference of the International Rubber and Other Tropical Products Exhibition on June 14, 1921.

In the introduction, Mr. E. R. Bolton draws attention to the urgent need for extended and comprehensive research on modern scientific lines on the various problems connected with the oil palms of the British West African Colonies, and points out that scientific cultivation and treatment would undoubtedly lead to increased yields of palm oil and palm nuts.

Dr. Rutgers' paper treats of "The Cultivation of the Oil Palm on the East Coast of Sumatra," a subject which has been dealt with in this Bulletin (1920, **18**, 209). It is estimated that if planting in Sumatra is carried out on the scale which is contemplated, the total area devoted to the oil palm will attain to about 100,000 acres within the next ten years, and the amount of oil available for export a few years later will be nearly 100,000 tons.

The subject of M. Edmond Leplae's paper is "Oil Palm Groves in the Belgian Congo." An account is given of the distribution of the trees and the methods employed for preparing the palm oil and kernels in that country, and special reference is made to the work of Lord Leverhulme's Anglo-Belgian Company, which obtained from the Belgian Government a concession of about 750,000 acres of oil palm forest and has erected and equipped a number of large factories.

Mr. Paul Tingey's paper, entitled, "An Epitome of the Results of Transporting Oil Palm Fruit from West Africa, and the Storage of same in England," deals particularly with an experiment which was carried out with the object of ascertaining whether the development of free fatty acids in the fruits during transport could be reduced by means of cold storage. The results show that the oil obtained from fruits which had been refrigerated had a decidedly lower acid value than that from fruits stored under ordinary conditions.

The book concludes with some observations by Mr. Lewis A. Smart on the subjects discussed in the three papers.

FOREST MENSURATION. By Herman Haupt Chapman, M.F. (Harriman Professor of Forest Management), Yale University. Pp. xxii + 553, 8vo, 9 × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1921.) Price 30*s*.

This, though essentially a new work, is designed—at that author's request—to replace H. S. Graves's *Forest Mensuration*, published in 1906. It is divided into three parts dealing respectively with the measurement of felled timber, of standing timber, and of timber-growth, thus appealing to the forester as well as to the timber-merchant. Although at once thorough and practical, the first part is so implicated with local customs, log rules and an American terminology as to have merely a slight academic interest outside the United States. The second part, describing hypsometers and the methods of the timber "cruiser," is rather more general in its applicability, so far as the extensive pure or semi-pure forests of temperate latitudes are concerned; but is scarcely applicable to the mixed forest of equatorial regions. Even the third part appears to consider the conditions of the even-aged plantation and the regularly tapering conifer rather than natural mixed hardwood forest. Useful tables of the cubic-foot content of cylinders of various diameters, of the board feet obtainable in sawing logs, and of the conversion of such English figures as cubic feet per acre into cubic metres per hectare are appended; but, whilst a few yield-tables for particular species are given in the text of the work, the main volume tables are merely an index to those published in the *Bulletins* and *Circulars* of the United States Forest Service. As these cannot be readily accessible to timber workers in the backwoods or outside America, it would seem to have been preferable, even at the expense of a good many additional pages, to have given at least a summary of these results; and, though most of the technical terms employed are defined when first used and entered in the index, a glossary also would have been an advantage.

THE PRINCIPLES OF LEATHER MANUFACTURE. By H. R. Procter, D.Sc., F.I.C. Second Edition. Pp. viii + 688, 8vo, 10 × 6¾. (London: E. & F. N. Spon, Ltd., 1922.) Price 32*s*.

This work, the first edition of which was published eighteen years ago, is well known as a standard treatise on leather manufacture. It has now been brought up to date, and is thus fitted to retain its position as a book

indispensable to the leather trades chemist and practical tanner.

The general order and arrangement of the first edition have been maintained, but the great progress in the scientific principles of the leather industry which has taken place has necessitated a thorough revision of most of the chapters, besides the inclusion of much additional material. The book has, consequently, considerably increased in bulk, not only as regards the number of the pages, but also in their size. As might be expected, the parts which have been subjected to most alteration are those dealing directly with the chemistry of the subject, which comprises physical, colloidal and bio-chemistry.

In the concluding chapter the author conveniently summarises the most important advances which have been made since the issue of the first edition. Additional information is furnished by five appendices, which include articles by different authors on: The Theory of Swelling of Gelatine and Hide; Acidity of Tan Liquors; Caustic Alkalinity of Lime Liquors; and also a list of coal-tar dyes now available for dyeing and staining leather, compiled by M. C. Lamb.

The present volume contains some excellent reproductions of micro-photographs, and many other illustrations which are absent from the earlier edition.

Distillation Principles and Processes. By Sydney Young, M.A., D.Sc., F.R.S. Pp. xiii + 509, 8vo, $8\frac{5}{8} \times 5\frac{3}{4}$. (London: Macmillan & Co., Ltd., 1922.) Price 40*s*.

This volume is intended to replace the author's previous book *Fractional Distillation*, published in 1903. The present work, however, is not merely a comprehensive revision of this earlier publication, but has been rendered of considerably greater value through an extension of its scope, so as to include distillation on a large scale as carried out in the manufacture of economic products. To cover so wide a ground, the author, who although himself one of the greatest authorities on distillation, has secured the co-operation of experts in special branches of industrial distillation. In the first section, which comprises twenty chapters or nearly half the book, the author deals very thoroughly with every aspect of fractional distillation, both from theoretical and practical standpoints, and supplies a chapter on sublimation. The remaining sections are devoted to distillation in connection with manufactured products. One on "Distillation of Acetone and *n*-Butyl Alcohol on a Manufacturing Scale" is contributed by

J. Reilly, M.A., D.Sc., F.R.C.Sc.I., F.I.C., and the Hon. F. R. Henley, M.A., F.I.C. The preparation of these compounds by the fermentation process is described, and also the production of acetone from acetate of lime, and from wood spirit. The same authors furnish another section on "Distillation of Alcohol on a Manufacturing Scale." A contribution on "Fractional Distillation as applied to the Petroleum Industry" is written by J. Kewley, M.A., F.I.C., who gives descriptions of periodic and continuous distillation processes, distillation under reduced pressure, and various other distillation methods. The subject of "Fractional Distillation in the Coal Tar Industry" is well treated by T. H. Butler, Ph.D., M.Sc., F.I.C., and that of the "Distillation of Glycerine" is dealt with by Lieut.-Col. E. Briggs, D.S.O., B.Sc. The concluding section by T. H. Durrans, M.Sc., F.I.C., entitled, "The Distillation of Essential Oils," discusses the subject in a practical manner from the preparation of the raw material to the purification of the essential oil. The book contains 210 illustrations and diagrams and 128 useful tables.

THE OIL ENCYCLOPEDIA. By Marcel Mitzakis. Pp. xvi + 551, 8vo, $8\frac{3}{4} \times 5\frac{1}{2}$. (London: Chapman & Hall, Ltd., 1922.) Price 21s.

This work may be regarded as a second edition of the *Oil Encyclopedia* written by the same author, and published as a supplement to the *Petroleum World* in 1912–13. In the preface it is stated "that the present volume can hardly be said to bear any resemblance to the original work. Every single item has been revised, enlarged, and in most cases completely rewritten." This is not strictly correct, as scores of items in the original work have been reproduced word for word in the present issue. There are, however, considerable additions, and the statistical matter generally has been brought up to date. Among the countries under the headings of which additional or entirely new matter has been introduced are the following: Australia, Baku, Borneo, Brazil (oil shales), Bulgaria (oil shales), Canada, Czecho-Slovakia, Egypt, England, Galicia, Japan, Java, Mesopotamia, Mexico, Persia, Roumania, Russia, the United States, and Yugo-Slavia. Articles which have been enlarged include: Dephlegmator or separator, depth of oil wells, and gasoline; and among entirely new matter we have: Germ process for manufacturing lubricating oils; the freezing process for shutting off water (an old process adapted to well-drilling); tanks (storage); and toluene.

The geographical information is not always up to date;

for instance Carniola, which now forms part of the new State of Yugo-Slavia, is said to be in Austrian crown land.

The work is fairly comprehensive and useful, but its value would have been increased had there been included in it many more names and descriptions of tools and appliances used in drilling wells, and further terms relating to oil geology.

PETROLEUM: A TREATISE ON THE GEOGRAPHICAL DISTRIBUTION AND GEOLOGICAL OCCURRENCE OF PETROLEUM AND NATURAL GAS. By Sir Boverton Redwood, Bart., D.Sc., etc. With a Foreword by Sir Frederick W. Black, K.C.B. Fourth edition, 3 volumes. Pp. xxx + 1353, 8vo, 9 × 6. (London: Charles Griffin & Co., Ltd., 1922.) Price £5 5s.

The third edition of the late Sir Boverton Redwood's standard work on petroleum was published in 1913, and was reviewed in this BULLETIN (1913, **11**, 548). In the new edition there are numerous revisions of, and additions to, the text, and several new maps, which have been specially prepared for it. One plate, in four sections, shows the oil and gas fields of the United States, and the geological portion of the text relating to those fields has been largely rewritten and brought up to date by American oil and gas geologists. There are new maps of Egypt and California, and a map of Southern Mexico, in which the various pipe lines to Tampico and Tuxpam are marked.

More information might well have been given on certain recent developments. For example, the geology of Mexican oilfields and those of South American countries are somewhat scantily treated. Under Mexico, there is no reference to the first part of Miguel Bustamante's standard work on the petroleum deposits of that country, and under Peru there is no mention of the important contributions to Peruvian oil geology by R. A. Deustua, V. F. Marsters and others.

The sections on the physical and chemical properties and the origin of petroleum have been brought up to date, but that on production contains little additional matter, and, with a few exceptions, the tools and appliances figured and described are those which were in use when the first edition was published, a quarter of a century ago. Some of these tools have since been improved, and others have been invented which have superseded the older forms.

Additional information appears on refining, the distillation of oil shale, pipe lines, storage tanks, tank steamships, testing, uses and regulations, and a new chapter has been

introduced on the natural gas industry. Following the text are appendices relating to statistics and import duties, an index, and a bibliography of 8,804 references. The last is a reprint of that in the third edition, although during the last decade the literature on petroleum has grown enormously, and an additional bibliography comprising only the most important writings that have appeared in recent years would have enhanced the value of the work. The index, too, is far from complete—for instance, many tools and appliances used in drilling have been omitted.

On the whole, however, this new edition is a decided advance on the third, and should have a place on the bookshelves of all interested in petroleum and allied minerals.

A Manual of Determinative Mineralogy. By J. Volney Lewis, Professor of Geology and Mineralogy in Rutgers College, State University of New Jersey. Third edition. Pp. iv + 298, 8vo, 9 × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1921.) Price 16*s.* 6*d.*

The fact that this work has now reached its third edition shows that it is held in considerable esteem in the United States. It is, however, seldom met with in this country.

The book is primarily intended for the guidance of students, but the author also considers it to be adapted to the requirements of the geologist and engineer. It consists principally of two sets of "tables" for the determination of minerals, (1) by means of their physical properties, and (2) by their behaviour before the blowpipe; but it also contains a brief outline of the six systems of crystallisation and lists of the chief minerals in each.

The utility of the physical tables is not very apparent. They are stated to have been included because the necessary apparatus for the other tests is not always available, and the classification adopted depends chiefly on streak, colour and cleavage. Since the last two of these are usually either variable or inconspicuous in practical specimens, it follows that the tables are only of use when hand-specimens of characteristic habit are considered, and thus have a very limited scope. A student should have access to a properly equipped mineralogical laboratory, and in this case his needs would have been better served if a much fuller list of properties had been compiled. These might include magnetic permeability and conductivity, and simple optical constants. As they stand, these tables are merely lists of the more obvious properties with which

the student would already be familiar as a result of his perusal of any elementary descriptive text-book. They are also extremely redundant, and in places inaccurate. Monazite, for instance, is twice described, the amount of thoria contained in it being given first as "up to 10 per cent." and again as "up to 19 per cent.," whereas actually samples have been found containing nearly 30 per cent.

The blowpipe and chemical tables are of much greater usefulness and accuracy, and form the chief recommendation to the volume. They are modelled on the well-tried tables of Brush and Penfield, and include 355 minerals, which are generally either of common occurrence or of some economic interest. Thorianite and baddeleyite (brazilite) are notable omissions.

A useful glossary of terms used in mineral literature forms an appendix to the volume.

THE ELECTRIC FURNACE. By J. N. Pring, M.B.E., D.Sc. Pp. xii + 485, 8vo, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Longmans, Green & Co., 1921.) Price 32*s*.

The electric furnace received considerable attention in the United Kingdom during the war, and the exigencies of the situation led to the manufacture in the United Kingdom of a number of electric furnace products which had previously been imported. This comprehensive book on the modern electric furnace and its products, which devotes special consideration to recent developments in Great Britain, is therefore particularly welcome.

After a brief historical summary of the development of the different types of electric furnace, a detailed account is given of those which are suitable for experimental and laboratory use. The discussion of the subjects of current supply and the measurement of high temperatures is followed by a description of the numerous processes which have been proposed, or are already in use, for the fixation of atmospheric nitrogen as nitride, cyanamide, nitrate and cyanide.

About one-quarter of the book is devoted to methods of electric furnace treatment for the smelting of iron ore, refining of steel and the preparation of ferro-alloys, and includes much useful information regarding consumption of power and materials. Processes are also described for electro-smelting of zinc, copper, tin and aluminium, and for the preparation of alundum, carborundum, and artificial graphite.

The concluding chapters deal with refractories for

electric furnace work, the design of electrodes, and recent hydro-electric power developments.

As a whole, the book gives an adequate account of the subjects dealt with, but in some cases the reader is left in doubt as to the final outcome of commercial trials which have been made with certain processes, and as to which of the processes described represent modern practice.

A useful classified bibliography is appended in addition to the numerous references given as foot-notes to the text.

The book contains numerous diagrams and illustrations of plant and installations, and will doubtless be of value to all interested in electro-metallurgy.

BOOKS RECEIVED

The Red Book of the West Indies: Historical and Descriptive, Commercial and Industrial, Facts, Figures, and Resources. Compiled and edited by Allister Macmillan, F.R.G.S. Pp. 424, 4to, 11 × 8¾. (London: W. H. and L. Collingridge, 1922.) Price 84*s*.

The Forests of India. By E. P. Stebbing, M.A. Vol. I. Pp. xv + 548, 8vo, 8¾ × 5¾. (London: John Lane, the Bodley Head Limited, 1922.) Price 42*s*.

The Directory of Paper Makers of the United Kingdom for 1922. Pp. 272, 8vo, 10½ × 7½. (London: Marchant, Singer & Co., 1922.) Price 5*s*.

Power Alcohol: Its Production and Utilisation. By G. W. Monier-Williams, O.B.E., M.C., M.A., Ph.D. Pp. xii + 323, 8vo, 8¾ × 5½. (London: Henry Frowde and Hodder & Stoughton, 1922.) Price 21*s*.

Land Drainage. By W. L. Powers, M.S., and T. A. H. Teeter, B.S. Pp. ix + 270, 8vo, 8½ × 5½. (New York: John Wiley & Sons, Inc.; London: Chapman Hall, Ltd., 1922.) Price 13*s*. 6*d*.

Fuel and Refractory Materials. By A. Humboldt Sexton, F.I.C., F.C.S. New edition, completely revised and enlarged, by W. B. Davidson, D.Sc., Ph.D., F.I.C. Pp. viii + 382, 8vo, 8¾ × 5¾. (London: Blackie & Son, Ltd., 1921.) Price 12*s*. 6*d*.

MANUFACTURE OF PORTLAND CEMENT. By Arthur C. Davis, M.Inst.C.E.I., M.I.Mech.E., F.C.S., etc. Third Edition, revised and enlarged. Pp. xiii + 416, 8vo, 8½ × 5¾. (Dublin: John Falconer, 1922.) Price 25*s.*

THE RIFT VALLEYS AND GEOLOGY OF EAST AFRICA. By J. W. Gregory, D.Sc., F.R.S. Pp. 479, 8vo, 8¾ × 5½. (London: Seeley, Service & Co., 1921.) Price 32*s.*

THE MINERAL RESOURCES OF BURMA. By N. M. Penzer, M.A., F.R.G.S., M.R.A.S., F.G.S. With an Introduction by Colonel O. C. Armstrong, D.S.O. Pp. viii + 176, 8vo, 8½ × 5½. (London: George Routledge & Sons, Ltd.; New York: E. P. Dutton & Co., 1922.) Price 31*s.* 6*d.*

A TEXT-BOOK OF MINERALOGY WITH AN EXTENDED TREATISE ON CRYSTALLOGRAPHY AND PHYSICAL MINERALOGY. By Edward Salisbury Dana. Third edition, revised and enlarged by William E. Ford. Pp. ix + 720, 8vo, 9 × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1922.) Price 25*s.*

AN INTRODUCTION TO THE ANALYTICAL CHEMISTRY OF THE RARER ELEMENTS. By L. J. Curtman. Pp. 64, 8vo, 8¾ × 5½. (New York: College of the City of New York, Department of Chemistry, 1922.) Price $1.25.

A TEXT-BOOK OF FIRE ASSAYING. By Edward E. Bugbee. Pp. ix + 254, 8vo, 9 × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1922.) Price 15*s.*

SURVEYING FOR SETTLERS: A simplified handbook for the use of pioneers, farmers, planters, and others settling in new countries. By William Crosley, M.I.C.E., M.I.M.M. Pp. xii + 149, 8vo, 7 × 4½. (London: Crosby, Lockwood & Son, 1922.) Price 7*s.* 6*d.*

MINERAL LAND SURVEYING. By James Underhill, Ph.D. Third Edition, revised. Pp. viii + 237, 8vo, 7¾ × 5½. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1922.) Price 17*s.* 6*d.*

GENERAL ECONOMIC GEOLOGY. By William Harvey Emmons, Ph.D. Pp. xiii + 516, 8vo, 9½ × 6. (New York and London: McGraw-Hill Book Company, Inc., 1922.) Price 20*s.*

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

The following summaries have been prepared from a selection of the Reports made by the Director of the Imperial Institute to the Dominion, Colonial and Indian Governments.

RESULTS OF THE EXAMINATION OF COTTON FROM TANGANYIKA

TOWARDS the end of 1921 and at the beginning of the present year, a number of cottons produced in different districts of Tanganyika were received at the Imperial Institute from the Director of Agriculture. The results of their examination, recorded in the present article, are of interest as indicating the character of the various types of cotton at present grown. An account of the position of the cotton-growing industry in Tanganyika and its possibilities is given on pages 173–184 of this BULLETIN.

Cottons from Morogoro District (cf. *Table I*).—These resembled one another in character and appearance, and the plants from which they were derived probably represent a long-stapled variety which has undergone degeneration. The chief defects exhibited were irregularity in length and strength and the presence of stained and immature fibre. Sample No. 4 was the strongest, but was less valuable than No. 1, owing to its being more stained.

The results of the examination indicate that these cottons are of irregular character, but that they could be improved by careful seed selection.

Cottons from Mwanza District (cf. *Table II*).—These were similar in character to the cottons from the Morogoro district, and, like the latter, appear to have been derived from a deteriorated form of a long-stapled type. The

variations in length and strength shown by these samples were even more pronounced than in the Morogoro cottons.

Nos. 1, 4 and 8 were the cleanest and Nos. 1 and 2 the best in strength and quality. Nos. 3, 5, 7 and 9 were all more or less badly stained and dirty; No. 3 was the worst in this respect, and also the weakest.

The pronounced irregularity of length and strength of the fibre could be remedied by a system of seed selection.

Cottons from Rufiji District (cf. *Table III*).—These cottons were generally superior in quality to those from the Morogoro, Mwanza and Lindi districts. They were however of similar type, being soft and lustrous and exhibiting considerable variation in length.

With the exception of Nos. 6 and 8, which were badly stained, of uneven strength and of somewhat poor appearance, the cottons were clean, of satisfactory strength, and of good but rather irregular length of staple.

If the varieties of cotton from which these samples were derived were submitted to careful selection and cultivation, cotton of excellent quality could probably be produced which would be readily saleable at good prices.

Cottons from Lindi District (cf. *Table IV*).—These cottons showed considerable variation in strength and length of staple, and contained an appreciable amount of immature fibre. Samples 1, 2 and 4 were of poor appearance, but No. 3 was cleaner, less stained, and superior in other respects.

If plants of the variety from which No. 3 was obtained were submitted to selection experiments and careful cultivation, there seems no doubt that a valuable type of cotton could be established, which would furnish a crop of excellent cotton well suited to the requirements of the Lancashire market.

The cottons, like those from the other districts, were more or less stained, and it was pointed out to the Tanganyika authorities that attention should be directed to the cause of the stains and that suitable measures should be adopted for the control of pests.

TABLE I

COTTONS FROM MOROGORO DISTRICT

No.	Locality.	Description of lint.	Strength.	Length of fibres.	Nominal commercial value.[1]
					Per lb.
1.	Morogoro.	Soft, lustrous, cream-coloured, slightly stained, and containing whole and broken seed and some immature fibre.	Moderate.	0·8 to 1·4 in.; mostly 1·0 to 1·2 in.; aver. 1·1 in.	12·00*d.*
2.	Myombo.	Soft, lustrous, cream-coloured, considerably stained and containing whole seed, pieces of broken seed-coat and a little leaf. Much immature fibre was present.	Fairly good.	0·7 to 1·5 in.; mostly 0·8 to 1·1 in.; aver. 1·0 in.	11·50*d.*
3.	Kimamba.	Similar to No. 2 (from Myombo).	Fairly good.	0·7 to 1·5 in.; mostly 0·9 to 1·1 in.; aver. 1·0 in.	11·50*d.*
4.	Dinimke.	Soft, lustrous, cream-coloured, clean and fairly free from immature fibre, but rather stained.	Good.	0·8 to 1·5 in.; mostly 1·0 to 1·2 in.; aver. 1·15 in.	11·75*d.*
5.	Ngerengere.	Soft, lustrous, cream-coloured, rather stained and containing a small quantity of leaf and undeveloped seeds. Some immature fibre was present.	Fairly good.	0·7 to 1·3 in.; mostly 0·8 to 1·1 in.; aver. 1·0 in.	10·75*d.*

1 *With "Middling" American at 10·0d. per lb.*

TABLE II

Cottons from Mwanza District

No.	Description of lint.	Strength.	Length of fibres.	Nominal commercial value.[1]
				Per lb.
1.	Soft, lustrous, cream-coloured, slightly stained in places and containing some immature fibre.	Good.	0·9 to 1·5 in.; mostly 1·0 to 1·2 in.; aver. 1·1 in.	12·50*d*.
2.	Soft, lustrous, cream-coloured, stained in places, somewhat leafy and containing some immature fibre.	Fairly good.	0·8 to 1·5 in.; mostly 1·1 to 1·3 in.; aver. 1·15 in.	12·50*d*.
3.	Very soft, lustrous, cream-coloured, much stained and somewhat leafy. The sample contained a quantity of unginned cotton and seeds, and much immature fibre was present.	Variable; on the whole weak.	0·9 to 1·4 in.; mostly 1·0 to 1·3 in.; aver. 1·2 in.	6·40*d*.
4.	Soft, lustrous, cream-coloured, very slightly stained. The sample contained some immature fibre, but was almost free from seeds and leaf.	Moderate; much of the cotton was weak.	0·7 to 1·8 in.; mostly 0·9 to 1·2 in.; aver. 1·1 in.	12·00*d*.
5.	Very soft, lustrous, cream-coloured, much stained, somewhat leafy and containing a few whole and broken seeds. Some immature fibre was present.	Variable; on the whole rather weak.	0·8 to 1·6 in.; mostly 1·1 to 1·3 in.; aver. 1·2 in.	7·50*d*.
6.	Soft, lustrous, cream-coloured, slightly stained and fairly free from leaf. Some immature fibre was present.	Fairly good; but much rather weak.	0·7 to 1·4 in.; mostly 0·9 to 1·1 in.; aver. 1·05 in.	11·00*d*.
7.	Very soft, lustrous, cream-coloured, much stained and containing some whole and broken seed and much leaf. A considerable proportion of the fibre was immature.	Variable; on the whole rather weak.	0·8 to 1·7 in.; mostly 0·9 to 1·3 in.; aver. 1·1 in.	7·00*d*.
8.	Soft, lustrous, cream-coloured, slightly stained and leafy, and containing some whole and broken seed and a quantity of immature fibre.	Fair on the whole, but some weak.	0·7 to 1·3 in.; mostly 0·8 to 1·2 in.; aver. 1·0 in.	11·75*d*.
9.	Very soft, lustrous, cream-coloured, very stained and containing some whole and broken seed and much leaf and immature fibre.	Variable; on the whole fair.	0·7 to 1·6 in.; mostly 0·9 to 1·3 in.; aver. 1·0 in.	7·50*d*.

[1] *With "Middling" American at* 10·50*d. per lb.*

TABLE III

COTTONS FROM RUFIJI DISTRICT

No.	Locality.	Description of lint.	Strength.	Length of fibres.	Nominal commercial value.[1]
					Per lb.
1.	Utete.	Soft, lustrous, pale cream-coloured, clean and almost free from stains, but containing a little immature fibre.	Good.	0·8 to 1·8 in.; mostly 1·1 to 1·3 in.; aver. 1·25 in.	14·75*d*.
2.	"	Soft, pale cream-coloured, lustrous, clean, but slightly stained in places. Some immature fibre was present.	Good, but somewhat irregular.	0·5 to 1·4 in.; mostly 1·0 to 1·3 in.; aver. 1·1 in.	14·25*d*.
3.	M'tanza.	Soft, lustrous, pale cream-coloured, clean and free from stains. Some immature fibre was present.	Good.	0·8 to 1·6 in.; mostly 1·1 to 1·4 in.; aver. 1·2 in.	14·25*d*.
4.	"	Soft, lustrous, pale cream-coloured, fairly clean, but stained in parts. Some immature fibre was present.	Fairly good.	0·7 to 1·8 in.; mostly 1·1 to 1·3 in.; aver. 1·2 in.	13·50*d*.
5.	Mohoro.	Soft, lustrous, pale cream-coloured, clean, only slightly stained and containing a little immature fibre.	Good.	0·8 to 1·5 in.; mostly 1·0 to 1·4 in.; aver. 1·15 in.	13·75*d*.
6.	"	Soft, lustrous, pale cream-coloured, considerably stained and a little leafy. Much immature fibre was present.	Variable; mostly fairly good.	0·8 to 1·5 in.; mostly 1·0 to 1·5 in.; aver. 1·2 in.	9·00*d*
7.	Kikale.	Soft, lustrous, pale cream-coloured, clean and free from stains.	Good.	0·7 to 1·6 in.; mostly 1·1 to 1·5 in.; aver. 1·2 in.	14·00*d*.
8.	"	Soft, lustrous, pale cream-coloured, much stained and containing some whole and broken seed and much immature fibre.	Fairly good, but irregular.	0·7 to 1·6 in.; mostly 1·1 to 1·3 in.; aver. 1·1 in.	8·50*d*.

[1] *With "Middling" American at* 11·35*d. per lb.*

TABLE IV

COTTONS FROM LINDI DISTRICT

No.	Locality.	Description of lint.	Strength.	Length of fibres.	Nominal commercial value.[1]
					Per lb.
1.	Mikindani.	Soft, lustrous, pale cream-coloured, very stained and somewhat leafy. Much immature fibre was present.	Very irregular.	0·5 to 1·5 in.; mostly 0·8 to 1·3 in.; aver. 1·0 in.	9·50*d.*
2.	Mtere.	Pale cream-coloured, soft and lustrous, somewhat stained and rather leafy. Much immature fibre was present.	Very irregular.	0·5 to 1·6 in.; mostly 0·9 to 1·4 in.; aver. 1·1 in.	11·00*d.*
3.	Ndanda.	Soft, lustrous, pale cream-coloured, slightly stained and containing some immature fibre.	Fairly good.	0·5 to 1·5 in.; mostly 0·8 to 1·4 in.; aver. 1·1 in.	14·00*d.*
4.	Mtua.	Soft, lustrous, pale cream-coloured, very stained and somewhat leafy. Much immature fibre was present.	Irregular.	0·5 to 1·4 in.; mostly 0·7 to 1·1 in.; aver. 1·0 in.	9·00*d.*

[1] *With "Middling" American at 11·35d. per lb.*

NEW OIL NUTS FROM SOUTH AMERICA

I. Mamarrón Nuts

In this Bulletin (1917, **15**, 479) an account was given of the results of examination at the Imperial Institute of oil-yielding nuts, known as "Corozo" or "Cuesco," the product of a palm occurring in great abundance in the Magdalena Valley, Colombia. From the material then available it was thought that the palm was probably *Scheelea excelsa*, Karst. (= *Attalea excelsa*, Mart.), but further botanical specimens have since been received, and the Director of the Royal Botanic Gardens, Kew, considers that the palm is nearer to *S. insignis*, Karst. It was stated in the above article, on the authority of M. T. Dawe, F.L.S., then Director of the Tropical Agricultural Station, San Lorenzo, Colombia, that two varieties of the palm occur in the Magdalena Valley, one bearing large fruits and one small, and that the nuts received at the Imperial Institute represented the larger variety, but according to information subsequently furnished by him it appears that there are really three types of Corozo palm in Colombia, producing fruit of different sizes, and that the nuts which were sent in 1917 were of the intermediate size. Nuts from the large fruiting variety of the palm, which is known in the Magdalena Valley as "Mamarrón," were forwarded in 1920 for examination, as it was thought possible that they may be from a species distinct from those previously examined and may therefore have a different value as a source of oil. Specimens of these nuts were forwarded to the Director of the Royal Botanic Gardens, Kew, who stated that they belong to a species of Attalea, allied to *A. Cohune*, Mart., the tree yielding the cohune nut. Endeavours are now being made to obtain the necessary botanical specimens with a view to determining definitely the identity of each type of Corozo palm.

An account of the results of the investigation at the Imperial Institute of the mamarrón nuts is given in the following pages.

The nuts were light brown, roughly ellipsoidal in shape,

bluntly pointed at the base and more sharply at the apex. The average dimensions were: length 2½ in., and diameter 1½ in.

They were covered with a thin layer of light brown fibrous material, beneath which was a very hard woody shell, about ⅜ in. thick. Most of the nuts had only one kernel, but a few had two or three.

The kernels bore a thin, dark brown, brittle coat, the flesh being creamy white with an odour resembling that of coconut. About 25 per cent. of the kernels were badly attacked by insects.

The sample also included a number of entire fruits, similar in size and shape to the nuts, and having a thin, fibrous, dark brown pericarp, about $\frac{1}{16}$ in. thick. At the apex the fruits bore a hard woody point about ⅜ in. long.

The average weight of a single fruit was 47·5 grams, of a nut 43·0 grams, and of a kernel 5·3 grams. The fruits consisted of pericarp 9·5 per cent., shell 79·3 per cent., and kernel 11·2 per cent.; the nuts consisted of shell 87·6 per cent., and kernel 12·4 per cent.

The kernels contained 3·8 per cent. of moisture and on extraction with light petroleum yielded 69·9 per cent. of fat, representing a yield of 72·7 per cent. of fat from the moisture-free kernels. This is equivalent to a yield of 8·7 per cent. from the nuts as received, or 7·9 per cent. from the entire fruits.

The oil thus extracted was a cream-coloured, fairly hard, solid fat, with an odour resembling that of coconut oil. It was chemically examined with the following results, which are shown in comparison with those recorded for the fat yielded by the Cuesco (*Scheelea*) nuts previously examined at the Imperial Institute, and by Cohune kernels.

	Mamarrón kernel oil.	Scheelea kernel oil.	Cohune kernel oil.
Specific gravity at 100°/15° C.	0·8679	0·8644	0·868 to 0·871
Melting point	24·0° C.	29·0° C.	22·0° ,, 24·0° C.
Melting point of fatty acids	23·0° C.	25·3° C.	19·7° ,, 21·0° C.
Acid value	2·3	0·6	1·2 ,, 20·4
Saponification value	250·9	224·6	252·4 ,, 256·5
Iodine value . . *per cent.*	10·8	35·2	11·0 ,, 13·7
Unsaponifiable matter *per cent.*	0·4	0·7	0·2 ,, 0·3
Volatile acids, soluble	8·6	2·1	6·8 ,, 8·3
Volatile acids, insoluble	10·8	3·0	12·5 ,, 15·4
Refractive index at 40° C.	1·449	—	1·4490 ,, 1·4497

The residual meal left after the extraction of the fat from the kernels was cream-coloured and had a pleasant taste resembling that of coconut meal. It was analysed with the following results, which are shown in comparison with the corresponding figures for Cohune nut meal, the results in each case being calculated to represent the composition of meal containing 7 per cent. of fat :

	Mamarrón nut meal. *Per cent.*	Cohune nut meal. *Per cent.*
Moisture	12·6	9·5
Crude proteins	22·4	22·4
Fat	7·0	7·0
Carbohydrates (by difference)	41·3	40·0
Crude fibre	11·7	16·1
Ash	5·0	5·0
Nutrient ratio	1 : 2·5	1 : 2·5
Food units	115	113

The meal contained no alkaloids or cyanogenetic glucosides.

The export of Mamarrón nuts from Colombia would not be remunerative on account of the large percentage of shell, but the kernels, if in good condition and offered in commercial quantities, should realise about the same price as palm kernels, which are selling at £17 10*s.* per ton in Liverpool (June, 1922). The cracking of the nuts could probably be effected by the use of machines similar to those designed for treating Cohune nuts, and the kernels would have to be thoroughly dried before shipment.

The oil from the kernels should be suitable for use in the manufacture of margarine and other edible fats and would probably realise about the same price as palm kernel oil, the value of which is £36 10*s.* per ton in Liverpool (June, 1922). It is possible that the residual meal might be used as a feeding-stuff in a similar manner to coconut cake, but practical feeding trials would have to be carried out in the first place to ascertain its suitability for this purpose. The price of coconut cake in London is £9 15*s.* to £10 10*s.* per ton (June, 1922).

Mamarrón nuts are very similar in appearance to the closely allied Cohune nuts, whilst the constants of the fats obtained from the kernels of the two species and the

analyses of the residual meals are in very close agreement. The Mamarrón nuts are, however, distinct in character from the Cuesco or Corozo nuts (*Scheelea* sp. ?) received from Colombia in 1917, being larger and mostly containing only one kernel, which is, moreover, of a different shape and size from the *Scheelea* kernels. The kernel fat also differs from that of the *Scheelea* kernels, particularly in respect to its saponification and iodine values and the amounts of volatile acids present.

It was suggested that if Mamarrón nuts occur in sufficiently large quantities in Colombia to furnish commercial supplies of the kernels, steps should be taken to organise the collection of the nuts and the separation of the kernels for export.

II. "Fruta de Conejo" (Rabbits' Fruit)

These nuts, which accompanied the Mamarrón nuts referred to above, were stated to be derived from a small tree which is abundant on the foothills of the Cordilleras in the Magdalena Valley, and to be utilised locally for domestic soap-making. As the tree had not been previously identified botanically, specimens of leaf material were forwarded to the Director of the Royal Botanic Gardens, Kew, who stated that it belonged to a species of *Heisteria*, probably new, but that the material was insufficient for description.

The sample received at the Imperial Institute consisted of dark brown oval nuts, 1¼ to 1½ in. in length and 1 to 1¼ in. in diameter, with a thin woody shell enclosing a cream-coloured kernel. The kernels were 1 to 1¼ in. long and about 1 in. in diameter, and were covered with a very thin, pinkish-brown, papery skin. They had a shrivelled appearance and more than half of them were mouldy.

The nuts were composed of shell 34 per cent. and kernel 66 per cent. The average weight of a single nut was 10·6 grams, and of a kernel 7·3 grams.

The sound kernels contained 5·4 per cent. of moisture, and on extraction with ether yielded 61·2 per cent. of a clear, golden-brown, viscous oil, equivalent to a yield of 64·7 per cent. from the moisture-free kernels or 40·4 per cent. from the entire nuts as received.

The oil was examined with the following results:

Specific gravity at 15°/15° C.		0·9940
Melting point of fatty acids		below 10° C.
Acid value		4·2
Saponification value		187·8
Iodine value	*per cent.*	140·0
Unsaponifiable matter	*per cent.*	2·1
Volatile acids, soluble		0·2
Volatile acids, insoluble		Nil
Acetyl value		128
Refractive index at 40° C.		1·502

On heating, the oil decomposed suddenly at a temperature between 250° and 285° C., with the evolution of copious fumes and the formation of a carbonaceous residue. Prolonged heating at 200° C. for four hours caused the oil to polymerise and form a product somewhat resembling polymerised Tung oil.

The high iodine value suggested that the oil would probably possess drying properties, but it was found that thin films of the oil, both pure and treated with litharge, did not dry even on exposure to the air for a fortnight.

The residual meal left after the extraction of the oil was cream-coloured and had practically no taste. It was analysed with the following results, which are calculated for a meal containing 7 per cent. of fat:

	Per cent.
Moisture	10·5
Crude proteins	35·6
Fat	7·0
Carbohydrates (by difference)	29·5
Crude fibre	9·2
Ash	8·2
Nutrient ratio	1 : 1·3
Food units	136

The meal contained no cyanogenetic glucosides, but a trace of an alkaloid was present.

These Conejo nuts contain a large percentage of oil, which, although having a high iodine value, does not possess good drying properties, and therefore could not be utilised for paint manufacture. As already stated, the oil polymerises on heating, and it might be suitable for making rubber substitutes and for other technical pur-

poses for which polymerised oils are employed. Otherwise it could only be used as a low-grade oil for soap-making.

In view of the thin and easily removable shell of these Conejo nuts, the separation of the kernels should be a simple operation, but if this were done in Colombia it would be necessary to dry the kernels well before shipment in order to prevent their deterioration.

The residual meal has a high nutritive value, but in view of the presence of a trace of alkaloid, practical feeding trials would be necessary to determine its suitability as a foodstuff for cattle.

The Imperial Institute has suggested that a trial shipment of a few tons of the well-dried kernels should be made so that the technical uses of the oil and the value of the residual meal as a feeding-stuff may be determined.

AFRICAN OIL PALM NUTS FROM ANGOLA

During 1921, Mr. M. T. Dawe, who was sent by the Portuguese Government on a special mission to the Portuguese Congo to investigate the agricultural possibilities of that region, forwarded to the Imperial Institute nuts of three varieties of the African oil palm (*Elæis guineensis*) occurring in Angola. No particulars appear to have been published hitherto regarding the composition of oil palm nuts from Angola, and the results obtained in the case of the present samples are therefore of much interest in comparison with those previously recorded in this Bulletin for nuts from other parts of Africa (1909, **7**, 357; 1913, **11**, 206; 1914, **12**, 349). Of the three varieties forwarded, that known as "Ebala" is stated to be the commonest, "Tundwa" is the next most abundant, whilst the third, "Sombo," is said to be rather rare. As the results detailed below indicate, the first two varieties are thick-shelled forms, similar to the common West African variety, whilst of the two samples of "Sombo" nuts sent, one was thick-shelled and the other thin-shelled. The thin-shelled "Sombo" nuts are stated by Mr. Dawe to be much superior to the nuts of the oil palm growing

in the Gambia, and at his suggestion a sample of these nuts has been sent to that Colony for trial cultivation.

The nuts received were as follows :

No. 1. " *Ebala*."—Thick-shelled nuts, many of which were pointed at one end.

No. 2. " *Sombo*."—Thick-shelled roundish nuts tapering to a long point at one end. A few nuts contained three kernels and a number had two kernels, but approximately two-thirds of the nuts contained only one kernel.

No. 3. " *Sombo*."—Thin-shelled nuts, rather flatter than those of sample No. 2, and in many cases having a long pointed end. A few nuts contained three kernels, but most of them had only one.

No. 4. " *Tundwa*."—Very thick-shelled nuts, more irregular in shape than those of the two " Sombo " kinds (Nos. 2 and 3). Most of them contained only one kernel.

The nuts were examined with the following results:

	Palm Nuts from Angola.				Palm Nuts from the Gold Coast.			
	Ebala.	Sombo.	Sombo.	Tundwa.	*Abe-pa* (thick-shelled nuts).		*Abobo-be* (thin-shelled nuts).	
	No. 1.	No. 2.	No. 3.	No. 4.	No. 1.	No. 2.	No. 1.	No. 2.
Dimensions of Nuts :								
Average length in inches	1·2	1·34	1·26	1·1	1·2	1·0	0·75	0·5
Average diameter in inches . . .	0·7	0·79	0·80	0·80	0·85	0·7	0·6	0·42
Average weight in grams	5·7	4·44	4·65	6·45	8·3	4·4	2·5	1·1
Average thickness of shell in inches . .	0·14	0·12	0·06	0·23	—	0·15	0·05	0·04
Composition :								
Kernels . *per cent.*	22·4	35·0	48·0	21·8	25·0[1]	31·0[1]	54·0[1]	53·0[1]
Shells . . *per cent.*	77·6	65·0	52·0	78·2	75·0[1]	69·0[1]	46·0[1]	47·0[1]
Dimensions of Kernels :								
Average length in inches	0·7	0·57	0·78	0·68	0·8	0·7	0·55	0·40
Average diameter in inches . . .	0·5	0·44	0·48	0·4	0·55	0·4	0·50	0·35
Average weight in grams	1·22	1·1	1·96	1·24	2·1	1·6	1·4	0·45
Composition of Kernels :								
Moisture . *per cent.*	7·5	7·2	7·9	7·5	23·7	20·0	27·0	—
Oil, in kernels as received *per cent.*	48·3	51·7	48·4	48·6	—	41·0	—	—
Oil, calculated on moisture-free kernels *per cent.*	52·2	55·7	52·5	52·5	—	51·0	—	—
Oil, calculated on nuts as received *per cent.*	10·8	18·1	23·2	10·6	—	12·7	—	—

[1] *These figures were calculated on moist nuts, and are not strictly comparable with those for the Angola samples which refer to air-dry nuts.*

which are shown in comparison with those recorded for typical samples of "Abe-pa" and "Abobo-be" palm nuts from the Gold Coast examined at the Imperial Institute (*loc. cit.*, 1909, 7, 368).

The oils extracted by light petroleum from the kernels of the Angola nuts were all of normal appearance, that from No. 3 ("Sombo") being of a slightly more creamy tint than the other oils.

The kernels obtainable from nuts represented by these samples would in each case be readily saleable in the United Kingdom, and should realise the current prices for palm kernels (£18 10*s*. per ton in Hull, January 1922).

General Conclusions

It will be seen that the "Ebala" nuts (No. 1) are similar in size and quality to the thick-shelled "Abe-pa" nuts of the Gold Coast, but many of the nuts in the present sample were easily distinguishable from the latter variety by their pointed ends.

The two samples of the "Sombo" nuts differed considerably in the thickness of the shells. In the case of No. 2 the shells were 0·12 in. thick, which is approximately the same as in some of the ordinary thick-shelled West African types, whereas in No. 3 the shells were only 0·06 in. thick and these nuts would therefore be classed as thin-shelled.

The "Tundwa" nuts have very thick shells, averaging 0·23 in.

Of the four samples No. 3 ("Sombo") is the best, the nuts being thin-shelled, containing a high proportion of kernels, and yielding the highest percentage of palm kernel oil (calculated on the nuts). No. 2 ("Sombo") is the best of the other samples, giving a higher yield of kernels and palm kernel oil than the "Ebala" and "Tundwa" nuts, which are generally similar to one another as regards percentage composition and yield of oil; the "Tundwa" nuts, however, have the thicker shell.

INDIAN BEESWAX

During recent years attention has been increasingly devoted in India to the possibility of devising practical methods of lessening the gross adulteration of products intended for export in the hope of securing more extensive markets for Indian materials. In 1915 the Imperial Institute drew the attention of the Government of India to the serious menace to the trade in Indian beeswax occasioned by the system of adulteration (mostly with paraffin wax) which is widely practised (cf. this Bulletin, 1916, **14**, 224). It was pointed out that there was a very large demand for beeswax in Russia for the manufacture of church candles, for which purpose supplies free from adulterants were required, and that if a continuous supply of the pure product could be obtained from India there would be a good opportunity of securing the greater part of the Russian beeswax trade which was in German hands before the war.

Samples of beeswax representing material as received in Calcutta from the collecting centres and as exported, were examined at the Imperial Institute in 1918. The results showed that one of these samples was much adulterated with paraffin wax, but although the characters of the other samples differed considerably from those usually accepted for Indian beeswax, no definite indication of their adulteration could be obtained.

Very wide variations in the chemical constants of Indian beeswax had been recorded by other investigators, and it appeared probable that some of the samples which they had examined as pure wax were really adulterated products. In view of the demand for pure beeswax it was important that the constants of the Indian wax should be definitely established, and the Imperial Institute suggested to the Government of India that a comprehensive series of authentic samples from different districts, and from the different species of bees common in India, should be forwarded for examination.

As a result of this enquiry a number of samples of honeycomb and wax collected in Bengal and Assam, under the supervision of District Officers, were received

in 1919, and the results of their examination have recently been published by O. D. Roberts, F.I.C., and H. T. Islip, A.I.C., of the Scientific Staff of the Imperial Institute in the *Analyst* (1922, **47**, 246).

The following table gives in each case the District in India from which the sample was collected, a description of the sample as received, and the yield and appearance of the purified wax derived from it. The wax was obtained from the samples of honeycomb by melting them in boiling water and straining through calico. The partially purified wax so produced was boiled several times with water to remove all soluble impurities, and was separated, filtered and dried at 100° C. The samples of wax were purified in the same way, except that the preliminary straining through calico was omitted.

Sample No.	District from which sample was collected.	Description of sample as received.	Yield of purified wax expressed on samples as received.	Description of purified wax.
			Per cent.	
1	Cachar (Assam).	A small cake of clean pale yellow wax, with a very faint odour of honey.	98·2	Almost white.
2	Ditto.	A large cake of clean yellow wax, with a fairly strong odour of honey.	99·1	Bright pale yellow.
3	Ditto.	A cake of clean yellow wax, with a slight odour of honey.	98·6	Very bright yellow.
4	Ditto.	Balls (3·5 in. diam.) and cubes (3·5 in. sides) of pale coloured wax of dull appearance.	82·0	Dull yellow.
5	Sylhet (Assam).	Balls and lumps of sticky, brown, crude wax, from 1 to 2·5 in. diam., having a strong sugary odour.	47·0	Very pale yellow.
6	Ditto.	Lumps of pale, rather sticky wax, 1–3·5 in. long and 1–2 in. broad.	80·0	Bright yellow.
7	Ditto.	Balls of pressed honeycomb, 1–2·8 in. diam., light yellow to dark brown.	44·0	Pale orange.
8	Goalpara (Assam).	Dark brown honeycomb containing a good many dead bees.	36·0	Dirty brownish yellow.
9	Ditto.	A thin flat sheet of dark brown honeycomb, ½ × 10 × 6 in.	11·0	Pale yellow.
10	Ditto.	Dark brown, pressed honeycomb in the form of lumps and powder. A large number of dead bees were present in the comb.	35·0	Dark yellow.

Sample No.	District from which sample was collected.	Description of sample as received.	Yield of purified wax expressed on samples as received.	Description of purified wax.
			Per cent.	
11	Goalpara (Assam).	Two lumps of dark brown pressed honeycomb, practically devoid of odour.	43·0	Pale yellow.
12	Ditto	Brown pressed honeycomb with an odour of sugar.	18·0	Dark chocolate.
13	Ditto.	A ball of dull wax, 2 in. in diameter.	90·0	Pale yellowish-buff.
14	Ditto.	A ball of dark, sticky wax, 1¾ in. in diameter.	70·0	Chocolate.
15	Ditto.	Pressed comb, and a small lump of dark coloured wax.	40·0	Pale chocolate.
16	Ditto.	Two large cakes of wax, of a dark brownish-yellow colour.	98·7	Dull yellow.
17	Lakhimpur (Assam).	Pieces of pale yellow honeycomb of good appearance with a rather rank odour.	80·0	Very bright yellow.
18	Kamrup (Assam).	Dark coloured, pressed honeycomb, with an odour of sugar.	75·0	Very light in colour with a brown tint.
19	Khulna (Bengal).	Honeycomb with a slight sugary odour, containing a few dead bees and some larvæ of the wax moth.	28·0	Dull yellow.
20	Singhbhum (Bengal).	Honeycomb of fairly dark brown colour and devoid of odour. The comb contained a number of dead bees.	20·0	Pale yellow.
21	Ditto.	Pieces of greyish-brown honeycomb about 10 × 4 in., in good condition.	16·0	Pale orange.
22	Ditto.	A piece of brown honeycomb 14 × 10·5 × 1 in. which had been attacked by the wax moth.	27·0	Fairly bright yellow.
23	Howrah (Bengal).	Small pieces of greyish-brown honeycomb, containing a large number of dead bees.	44·0	Pale buff-yellow.

Information concerning the species of bee producing the wax was unfortunately not available except in the case of five samples, regarding which the following notes were furnished:

Nos. 5 and 9. "Probably *Apis dorsata.*"

No. 17. "*Apis dorsata,* bigger variety."

No. 21. "The common Indian bee."

No. 22. "Corresponding to the rock bee in England."

Specimens of bees obtained from samples Nos. 19, 20 and 23 were forwarded to the Imperial Bureau of

Entomology, and were identified in each case as *Apis dorsata*, F.

In several cases the samples of honeycomb yielded relatively small amounts of purified wax, as some of the combs consisted largely of organic fibrous tissue whilst others contained a considerable quantity of dead bees and honey. The crude waxes also in some cases furnished rather low yields of clean wax, as they contained an appreciable percentage of honey and other soluble impurities. Many of the samples contained a fair amount of mineral matter.

The purified waxes were submitted to chemical examination at the Imperial Institute with the results given in the table on page 159.

The following remarks may be made regarding the constants of the samples.

Nos. 1 *and* 8.—The genuineness of these samples of wax was indicated by the normal percentage of hydrocarbons and the values of most of the other constants, but otherwise, in view of their very low acid values, these samples would have been considered to be adulterated with paraffin wax.

Nos. 2, 3, 4, 6, 11, 13, 17, 18, 20 *and* 23.—The constants for these samples of wax agree approximately with those previously attributed to genuine Indian beeswax.

No. 5.—This wax had very abnormal constants, which differed considerably from those found for the remaining samples. Its extremely low acid value and correspondingly high ester-acid ratio, its high percentage of hydrocarbons, and the most decided result of Weinwurm's test, would all be generally regarded as definite proofs of adulteration with paraffin wax. There was, however, no corresponding lowering of the specific gravity and melting point, which were about normal.

No. 7.—This wax contained a rather high percentage of hydrocarbons.

Nos. 9 *and* 12.—These samples were too small to permit of complete examination.

No. 10.—This wax was rather abnormal in respect of its high specific gravity and melting point, and low acid value. The sample was too small for complete examination.

No. 14.—This resembled No. 1 in having a very low

No.	gravity at 15°/15° C.	point.[1]	value.	value.	Acid	value.	Seaber's test.	Hydrocarbons.	Appearance of solution obtained.
		°C.				Per cent.[2]	° C.	Per cent.	
1	0·9649	60·4	3·9	95·3	24·4	7·7	53	10·7	Opaque: became much thicker on standing.
2	0·9570	60·6	5·7	92·9	16·3	5·5	56	8·6	Slight opalescence: on standing, became less thick than No. 1.
3	0·9689	61·4	6·5	94·9	14·6	4·5	60	6·9	Opaque, rather cloudy, fairly large precipitate on standing.
4	0·9626	61·4	2·6	90·2	34·7	8·1	56	15·7 (M.P. 49·4° C.)	Opaque: on standing became thick, semi-solid and pasty.
5	0·9684	61·0	3·7	96·0	26·0	6·1	59	8·2	Slight opalescence, less than No. 2: on standing became similar to No. 2.
6	0·9632	61·2	6·8	92·6	13·6	5·8	55	8·9	Similar to No. 5: on standing similar to No. 3.
7	0·9675	60·8	5·6	94·1	16·8	5·0	60	9·5 (M.P. 51° C.)	Opaque: on standing, similar to No. 3.
8	0·9621	61·1	7·1	87·4	12·3	6·2	62	11·3 (M.P. 50° C.)	Opaque: on standing, similar to No. 2.
9	0·9566	61·8	6·4	91·9	14·4	6·5	58	10·6	Opaque: very slight precipitate on standing.
10	0·9629	61·1	6·2	90·8	14·6	5·0	58	10·0 (M.P. 51° C.)	Very slight opalescence: on standing, similar to No. 7.
11	0·9621	60·9	—	—	—	—	—	—	—
12	0·9733	66·4	4·2	89·6	21·3	—	—	—	—
13	0·9688	60·6	5·8	89·5	15·4	—	—	—	—
14	0·9608	61·5	—	—	—	—	—	—	—
15	0·9619	61·1	7·6	92·6	12·2	4·9	58	9·2 (M.P. 49·5° C.)	Very slight opalescence: on standing, similar to No. 9.
16	0·9646	63·8	3·8	88·6	23·3	—	—	—	—
17	0·9717	61·4	7·5	92·5	12·3	—	—	—	—
18	0·9646	61·3	5·6	94·7	16·9	4·8	52	8·6 (M.P. 52·5° C.)	Slight opalescence: on standing, similar to No. 4, but not so thick.
19	0·9657	61·4	5·3	93·2	17·6	5·7	57	10·1 (M.P. 53·5° C.)	Very slight opalescence: practically no change on standing.
20	0·9711	60·7	5·1	93·0	18·2	5·4	Very indefinite, about 49°C.	9·4 (M.P. 50·2° C.)	Opaque: on standing, fair amount of precipitate.
21	0·9682	60·7	6·0	91·0	15·2	5·6	55	8·9 (M.P. 51·1° C.)	Very slight opalescence: on standing, became opaque.
22	0·9671	60·7	5·8	93·0	16·0	5·2	61	12·7 (M.P. 50·6° C.)	Clear solution: on standing, became opaque.
23	0·9555	60·8	6·7	89·0	13·3	5·6	60	12·9 (M.P. 52·5° C.)	Very slight opalescence: on standing, similar to No. 20.

[1] *By the open tube method.* [2] *Hübl, 17 hrs.* *M.P. = Melting-point.*

Note.—The occurrence of blank spaces in the above table is due to the sample being insufficient for the figures to be obtained.

acid value and correspondingly high ester-acid ratio. The sample was, however, too small for complete examination.

No. 15.—This wax has a somewhat high specific gravity, but otherwise the constants it was possible to obtain with the small amount of wax available were in fair agreement with those previously regarded as typical of genuine Indian beeswax.

Nos. 16 *and* 19.—The iodine value of these waxes was rather low.

No. 21.—This wax has a rather high specific gravity.

No. 22.—This contained a rather high percentage of hydrocarbons, and the specific gravity was rather low.

Apart from No. 5 which had very abnormal properties, and Nos. 9 and 12 which were too small for complete examination, the other samples examined had the following minimum, maximum and average constants :

	Specific gravity.	Melting point.	Acid value.	Ester value.	$\frac{\text{Ester}}{\text{Acid}}$ ratio.	Iodine value.	Salamon and Seaber's test.	Hydrocarbons.
		°C.				*Per cent.*		*Per cent.*
Minimum	0·9555	60·4	3·7	87·4	12·2	4·5	52	6·9
Maximum	0·9733	66·4	7·6	96·0	26·0	7·7	62	12·9
Average	0·9652	61·4	5·8	92·1	16·7	5·6[1]	57·6[2]	9·8[1]

[1] *Average of* 16 *samples only.* [2] *Average of* 15 *samples only.*

For comparison with these figures the following table

Country of origin.	Specific gravity.	Melting point.	Acid value.	Ester value.	$\frac{\text{Ester}}{\text{Acid}}$ ratio.	Iodine value.
		°C.				*Per cent.*
Germany .	—	63·5–64·5	19·2–20·4	72·0–77·0	3·6–3·8	7·5–8·0
Italy . .	—	64·5	21·5	75·0–77·5	3·5–3·8	10·7–12·7
Portugal .	0·966	—	18·4	73·5	4·0	—
Abyssinia .	0·958	65·0	20·8	72·7	3·5	—
Algeria .	—	63·5	20·5	79·0	3·8	10·0
East Africa	0·965	64·0	20·0	73·3	3·9	—
Madagascar	—	64·5	19·0	78·0–81·0	4·0–4·3	9·0–10·0
East India	—	63·0	7·0–7·5	89·0–94·0	12·5–13·5	8·6
China .	—	62·0–66·0	5·3–9·5	86·0–96·0	10·0–17·9	—
Japan .	0·8135–0·8207	65·0–66·5	5·6–8·2	—	—	10·0–14·1
India, No. 1[1]	0·951	63·5	4·7	72·9	15·5	11·4
India, No. 2[1]	0·967	60·5–61·0	6·2	83·1	13·4	6·7
India (average of present samples) .	0·9652	61·4	5·8	92·1	16·7	5·6

[1] *Samples examined at the Imperial Institute in* 1918.

gives the constants recorded in Lewkowitsch's *Chemical Technology and Analysis of Oils, Fats and Waxes*, 5th ed., vol. ii, pp. 909–911, for beeswaxes from various other countries, together with the results obtained for two previous Indian samples examined at the Imperial Institute in 1918.

On comparing the figures in the foregoing tables it will be seen that the samples now under report agree very closely in their constants with the samples from India examined in 1918. In general, the Indian beeswaxes resemble the Chinese and Japanese varieties. These waxes form a distinct class of beeswax, and their constants differ in certain respects from those of waxes from other sources.

The constants of Indian beeswax as illustrated by the present samples do not fluctuate between very wide limits, but the divergence from those of the ordinary beeswaxes of commerce is clearly marked, particularly in the usually lower melting point, lower acid value and higher ester value, with the consequent higher ratio of ester and acid values. The iodine value is also on the whole lower than that of beeswaxes from other sources.

An outstanding feature of the results obtained with the present samples is the extremely low acid value of the waxes, the figures being considerably lower than those which have hitherto been regarded as consistent with the purity of beeswax.

It is clear from the present results that Weinwurm's test is of no value for the detection of paraffin wax in samples of Indian beeswax since the solutions obtained were more or less cloudy, whereas according to Weinwurm the solution obtained in this test should be transparent and clear if the beeswax is pure.

Other investigators have observed that Weinwurm's test is not applicable to Indian beeswax.

Salamon and Seaber's test is also shown to be not entirely trustworthy in this connection. According to these workers the "clouding-point" is 56° C. for beeswaxes of the East Indian type, results above this figure indicating the presence of paraffin wax.

The results of this investigation are of considerable interest as indicating the variations which may occur in the constants of authentic samples of Indian beeswax

and also in affording a comparison with beeswax from other sources. As already stated, these Indian waxes differ considerably in their constants from the waxes obtained from most other countries.

No comparison of the waxes obtained from the different species of bee occurring in India has been possible, as the information furnished in connection with the samples was very incomplete. Some of the samples ascribed to definite species were destroyed by wax moth, and only in one or two of the remaining cases was it quite clear, from the labels and the information available, from which species the wax was actually derived.

DISTILLATION PRODUCTS OF WEST AFRICAN WOODS

REFERENCE was made in a previous article in this BULLETIN (1916, **14**, 566) to the dependence of the United Kingdom on foreign countries for a very large proportion of its supplies of wood distillation products, which include acetate of lime, acetic acid, acetone, methyl alcohol and wood tar, and to the possibility of extending the wood distillation industry in various parts of the Empire. Although Canada still remains the only country in the Empire exporting these products to Great Britain, increasing attention has been devoted in recent years to the destructive distillation of wood in several parts of Africa. The results of distillation trials in the Imperial Institute laboratories with consignments of black wattle wood and olive wood from Kenya Colony (East Africa Protectorate) and with talh wood (*Acacia Seyal*, Del.) from the Sudan (see this BULLETIN, 1916, **14**, 570; 1919, **17**, 493) showed that the yields were satisfactory and equal to those usually obtained from other hardwoods.

Endeavours are now being made to find uses for the large quantities of wood which will become available in the process of clearing West African jungles for planting purposes, and in this connection small samples of the following woods were recently forwarded to the Imperial Institute to ascertain the yields of the products which could be obtained from them by distillation.

(1) *Silk-cotton wood* (*Eriodendron anfractuosum*).—Weight, 6 lb. A light, fairly soft wood of pale brownish-white colour.

(2) "*Kaku,*" *or red iron wood* (*Lophira procera*).—Weight, 6¾ lb. A heavy, very hard wood of reddish-brown colour.

(3) "*Odum*" (*Chlorophora excelsa*).—Weight, 3¾ lb. A fairly heavy and moderately hard wood, varying from pale brown to pale straw colour.

(4) *Umbrella wood* (*Musanga Smithii*).—Weight, 2 lb. A very light, fibrous, soft wood of pale brownish-white colour. This wood has also been examined recently at the Imperial Institute to determine its suitability for the manufacture of artificial limbs and of paper pulp (see this BULLETIN, 1921, **19**, 10).

The samples were not large enough for complete distillation trials to be carried out, and further quantities of the four woods were therefore obtained from the collections of the Imperial Institute. The latter material consisted of well-seasoned timber, and the results now recorded may therefore differ slightly from those which would be obtained by the distillation of fresh timber in West Africa. Air-dry timber that has been seasoned for a period of one or two years usually gives the most satisfactory results on distillation.

The woods were submitted to dry distillation, with the results given in the following table, which are shown in

	Silk-cotton wood.	Kaku.	Odum.	Umbrella wood.	Oak.	Pine.
Weight of material distilled . . *lb.*	2½	6½	4	1½	3½	3
Time required for the distillation . . *hours*	3½	4	5	1¾	3½	3½
Yield of:	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Charcoal	28·4	30·3	32·0	27·7	25·0	29·2
Crude pyroligneous acid .	43·7	40·6	38·5	43·7	53·9	40·1
Containing:						
Acetic acid . . .	2·0	2·4	2·4	3·7	4·4	2·2
Dissolved tar . . .	4·6	3·8	2·9	3·7	5·8	5·1
Wood naphtha, methyl alcohol, and acetone	1·5	1·2	1·3	1·4	1·3	0·9
Tar, separated . . .	8·2	7·2	8·0	8·0	6·4	12·9
Containing:						
Acetic acid . . .	0·3	0·3	0·3	0·4	0·4	0·3
Total yield of tar . .	12·8	11·0	10·9	11·7	12·2	18·0
Total yield of acetic acid .	2·3	2·7	2·7	4·1	4·8	2·5

comparison with corresponding figures obtained at the Imperial Institute for typical hard and soft woods, viz. oak and pine.

On distillation all four woods yielded inflammable gases, which were burnt under the still.

The separated tar was, in each case, a thin, mobile, brownish-black liquid.

The charcoals obtained had the following characters:

Silk-cotton wood.—A light, soft, porous charcoal, which marked paper readily and ground to a fairly smooth, soft, deep black powder. The charcoal burnt easily and held fire well.

"*Kaku.*"—A hard charcoal, with a dull metallic ring. It did not mark paper readily, and ground to a hard, gritty powder of greyish-black colour. This charcoal burnt slowly and required a good draught to ensure its combustion.

"*Odum.*"—A fairly soft charcoal, with a light metallic ring. It marked paper readily, and possessed better covering power than the charcoal from either the umbrella wood or the silk-cotton wood. It ground to a harsh black powder with a somewhat greyish tint. This charcoal burnt easily and held fire well.

Umbrella Wood.—A light, very soft, porous charcoal, which marked paper readily and ground to a smooth, soft, black powder, with a greasy, lustrous appearance. The charcoal burnt very easily and held fire well.

In comparison with a typical soft wood, such as pine, the umbrella wood and silk-cotton wood gave very satisfactory yields of distillation products. The yield of acetic acid from the umbrella wood is noticeably high for a soft wood, whilst that from the silk-cotton wood was approximately the same as that obtained from pine. Judged by the same standard, both umbrella wood and silk-cotton wood gave normal yields of charcoal, high percentages of wood naphtha and low amounts of tar.

The kaku and odum woods furnished considerably less acetic acid than a typical hard wood such as oak, but the yields of tar and wood naphtha were approximately the same as from oak, whilst that of charcoal was higher.

The successful utilisation of these woods by destruc-

tive distillation will depend on the possibility of finding remunerative markets for the products. The acetic acid (if offered in the form of brown acetate of lime) and the wood naphtha are the most important of these, and could be disposed of in the United Kingdom. As regards the charcoals, those from the umbrella wood and silk-cotton wood might possibly be used as pigments, as a substitute for Frankfort black, but it is not likely that they could be remuneratively shipped to this country. All the charcoals could be employed locally as fuel, whilst the ash would probably be suitable for use as a manure. The tars might be disposed of in West Africa for preserving timber.

The woods usually employed for destructive distillation are those giving the highest yield of acetic acid (*i.e.* hard woods), a yield of about 4 per cent. being commonly obtained. The yields from the present samples, with the exception of the umbrella wood, fall much below this figure.

The question as to whether the destructive distillation of these woods in West Africa would be remunerative could only be decided by a careful consideration of the capital cost involved, the expense of working, the local demand for the products and the prices likely to be realised.

SPECIAL ARTICLE

AGRICULTURAL DEVELOPMENT IN THE CAMEROONS

By F. Evans

Supervisor of Plantations, Cameroons

The portion of the Cameroons which, under Mandate from the League of Nations, is now administered by Great Britain, has an area of some 33,750 square miles, carrying a population estimated at 644,000. The northern part has been attached for administrative purposes to the Northern Provinces of Nigeria, while the south, consisting of some 17,548 square miles, forms what is now known as the Cameroons Province.

This new province, which is subdivided into the four administrative divisions of Bamenda, Ossidinge, Kumba and Victoria, consists of a narrow wedge of territory about 80 miles wide and 270 miles long. It is bounded by the new French Sphere of the Cameroons on the east, by the provinces of Muri and Yola on the north, by the Calabar and Ogoja provinces on the west and by the Atlantic Ocean on the south.

The name Cameroons is derived from the Portuguese Rio-dos-Camaroes, or "shrimp river," which was the name given to the Duala estuary by the early Portuguese navigators. Victoria, the chief port, was named after Queen Victoria by the Baptist missionaries about the year 1858, who, having been expelled from the Spanish island of Fernando Po, settled on the mainland prior to the German occupation.

The tribes found in the coastal regions are of Bantu stock, mostly primitive forest people who make good agricultural labourers. Their staple foodstuffs are plantains, coco-yams, maize, beans, fish and palm oil. Imported rice is also appreciated.

The physical features of the country show great diversity. To the east and west of Victoria, around the Mungo River and the Rio-del-Rey estuaries mangrove swamps are found. From Victoria inland to Kumba the country consists of a series of broken hills covered with forest growth and is everywhere well watered. The great Cameroon mountain, 13,350 feet, is volcanic; but, while disturbances have occurred, one as recently as the present year, 1922, no serious eruptions are on record. The mountain is some twenty-five miles long, and runs in an easterly direction. From Kumba the land rises to the Central African plateau at about 6,000 feet, and the land here consists largely of grass country.

The principal rivers in the southern portion are the Mungo on the east, forming a part of the boundary between the British and French spheres, and the Meme on the west, running into the Rio-del-Rey estuary. These streams are navigable for small launches during the rainy season, the Mungo as far as Mundame and Mukonje Plantations, and the Meme as far as the Bonge-Bavo Plantations.

Plate I

Fig. 1.—Bibundi Estate. Manager's house, showing landing jetty and beach stores.

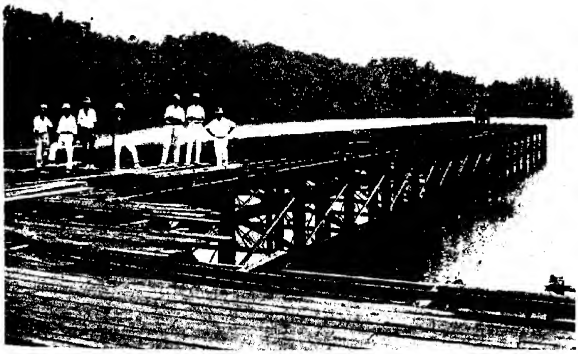


Fig. 2.—Tiko Banana Estate. Pier at Tiko.

Fig. 1.—West African Plantations, Victoria. Cocoa drying house and store at Bota

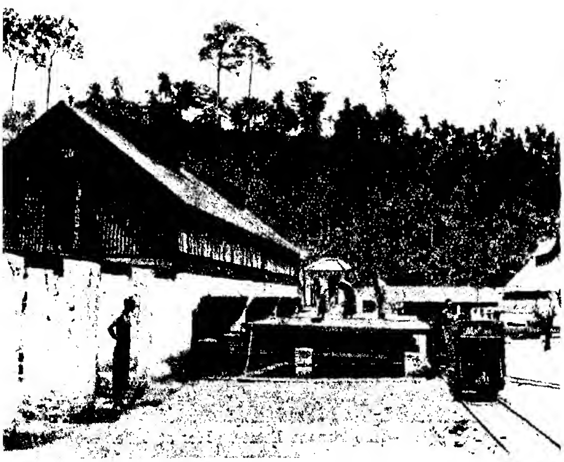


Fig. 2.- Moliwe Estate. Cocoa drying house.

The Victoria and Kumba Divisions, in which are the ex-enemy plantations, where cocoa, rubber, oil palms, coffee, kola and bananas are grown, lie around the great mountain and south of Kumba, extending from about the fifth to the sixth degree of latitude. The mean average temperature at Victoria is 77° F. The average rainfall at Buea is about 100 inches and at Victoria 170 inches.

At Buea (3,200 feet) and Bamenda (4,726 feet) European cattle imported by the Germans thrive, and at Buea there is a dairy and vegetable farm (cf. this *Bulletin*, 1913, **11**, 470). European vegetables and flowers grow well, and the rose-bordered avenues in Buea are reminiscent of Southern Europe.

Good anchorage for ocean steamers is found at Victoria in Ambas Bay, a beautiful, island-girt harbour. At Tiko on the Mungo River a pier and wharf were built by the West African Fruit Company to accommodate ships for the banana trade, which had been started just before the outbreak of war. At Rio-del-Rey there is a good deep water harbour suitable for sea-going steamers.

Transport problems in the southern part of the province are met fairly satisfactorily by the narrow-gauge railway built by the German West African Plantation Company, Victoria, which runs throughout the central estates and up to Buea. Water transport serves some estates on the Mungo and Meme rivers. The Government road now under construction from Victoria to Bamenda through Kumba will further facilitate transport. Mules are employed on several of the properties, where horses also are used for riding. This part of the province is very rich in oil palms, and mahogany, camwood, ebony and other valuable timber trees are plentiful. Coconuts are grown near the villages everywhere, but have not been cultivated on the plantations.

The German Imperial Government sought to bring into being within the shortest possible time a well-developed and highly organised tropical colony, and the form of administration adopted in the thinly populated districts around the great Cameroon mountain had a direct influence on the success of the plantations established in that region. European occupation of land for planting purposes was

encouraged, and the Government undertook to supply and control all labour both for public works and private enterprise. These methods, although contrary to the methods accepted at the present day, had the effect of rapidly building up a staple industry and developing large tracts of uninhabited forest land. Certain other results were obtained, including the education of the native by showing him the benefit of systematic planting, intensive cultivation and the production of a good grade of cocoa, which takes a high place in the markets of the world.

The German Government appointed agricultural experts who rendered valuable assistance to the planters. Research work was commenced by Professor E. Preuss and continued by Dr. Fickendey and other specialists in botany and agriculture. Botanical Gardens and an Experiment Station were laid out at Victoria (*loc. cit.*). Laboratories, herbarium, museum, meteorological station, agricultural school and fully equipped experiment station, for dealing with cocoa, rubber and other crops, were, at the time war broke out, in full working order, and Dr. Fickendey was engaged on work of a highly important character.

The results of the Department's experimental work were published regularly. Some of these publications are well known and of considerable value, and include works on rubber yields, diseases of cultivated plants, cocoa canker, tobacco-leaf fungus, oil palms and palm oil manufacture, and manurial experiments. The German official reports of 1913–14 on the agricultural experimental work carried out are of special interest. The cocoa experiments were varied and undertaken directly to assist the local industry. It should be mentioned that the period of ripening of cocoa in the Cameroons varies by two or three months on different estates in the plantation area, the crop season thus normally extending from July to February. There were some 3,375 acres of cocoa under experiment station control; this included areas on the Victoria Farms and other estates. As elsewhere in West Africa, the predominating variety of cocoa in the Cameroons is Amelonado, which is a strong-growing, hardy, heavy-bearing tree, which does not succumb readily to injury,

and produces a good quality of cocoa. The Forastero variety proved almost equally successful. Criollo, on the other hand, was proved to be too delicate, being easily overcome by injury, disease and insect pests, and was also found to bear irregularly. Increased yields from good varieties were sought by grafting Nicaraguan and Venezuela Criollos on to the strong Amelonado stock. Valuable work was commenced on the question of regeneration of old plantations. Several acres of old cocoa trees were interplanted. It was intended to find out whether land bearing old trees could successfully be made to carry the same crop for further generations of trees. Another method employed was to cut down some of the old trees and develop the sucker shoots. This was accomplished by inducing the independent rooting of these shoots by surrounding them with heaped-up earth kept in place by stones. Quite early it was found that such shoots develop more quickly into strong growing trees than do seedlings. They bore flowers and pods in the second year and in half the time it takes seedlings to come into bearing. The old stems were carefully removed to prevent fungus attacking the new plants. Manurial experiments yielded further important and interesting results. Each tree received 650 grams (1·34 lb.) of a mixture of two parts of sulphate of ammonia and superphosphate with one part of potassium chloride. Further, the empty pods from the previous crop were buried, sometimes with lime, and periodically turned over to aid decomposition, and were then used for manuring, the decomposed material being dug in round the trees. Some of the results from this treatment were that the prevalent brown rot was greatly reduced, the third season being almost entirely free from it.

It was found that in the humid Victoria Division heavy shade was generally unnecessary, and that closely planted areas thrived without shade trees; but in the more open, drier parts, such as the Tiko plains, shade was beneficial and the planting of permanent shade trees was advisable.

To assist small native planters to improve their fermentation, experiments were conducted on lines followed in the French Congo. Pods were heaped and occasionally turned. The fermentation taking place in the closed pods

appeared to result in reducing the bitterness of the cocoa bean, but had rather a bad effect on the colour, break and aroma.

Rubber tapping experiments were also carried out and Para rubber was found to give good yields. The tree grows vigorously and is undoubtedly well suited to the soil and climate of the Cameroons. An almost complete collection of all the known rubber-yielding plants in the world was obtained and planted in the Victoria Botanic Gardens. Several kinds were cultivated on a large scale; these included Hevea, Funtumia, Castilloa, Ceara, also the gutta-percha tree *Palaquium oblongifolium.* Plants of all kinds were got from Java and other parts of the tropical world, mainly through the Central Botanical Station for the Colonies in Berlin.

The oil palm (*Elæis guineensis*) plantations established in the Cameroons are an instance of the value of applying scientific methods to the development of the indigenous products which constitute the real inherent wealth of West and Central Africa. Experiments were conducted to prove trueness to type existing among the known common varieties. "Lisombe," the predominant thin-shelled variety and the best oil yielder, showed little tendency to reproduce true to type, the majority of its seedlings producing thick-shelled nuts (cf. this BULLETIN, 1920, **18**, 231). Planting distances were varied on three experimental areas to determine the most suitable spacing. Years of further work will be required before anything approaching satisfactory results in this matter can be obtained.

Experimental areas of numerous oil-yielding plants were laid out. These included *Mimusops Djave*, *Irvingia gabonensis*, *Pentadesma butyracea*, *Pentaclethra macrophylla*, *Carapa* sp. and *Butyrospermum Parkii.*

Indigenous field crops received their fair share of attention. The coco-yam "Makabo" (*Colocasia antiquorum*) was grown, three varieties being tried. Yams (*Dioscorea alata*) were planted in deep holes filled with humus, with most satisfactory results. Sweet potatoes (*Batatas edulis*), white and red varieties, were cultivated from cuttings planted crosswise on mounds prepared several

PLATE III

Fig. 1.—Mukonje Cocoa and Rubber Estate. Manager's house.

Fig. 2.—Mokundange Cocoa and Oil Palm Estate. Oil palm factory.

PLATE IV.—EKONA COCOA, OIL PALM AND RUBBER ESTATE

Fig. 1.—Electric switch station, carpenter's workshop and mono rail.

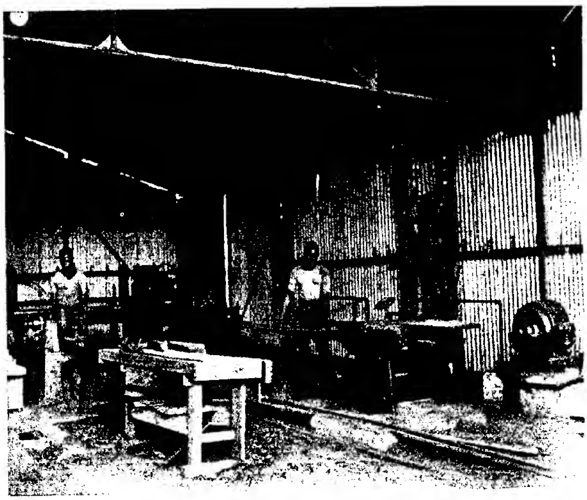


Fig. 2.—Interior of carpenter's workshop.

days before. A good potato rich in starch was thus obtained.

Leguminous crops grown for food purposes and green manuring included pigeon peas (*Cajanus indicus*), *Canavalia ensiformis*, *Dolichos biflorus*, ground nuts (*Arachis hypogæa*) and the ground beans (*Voandzeia subterranea* and *Kerstingiella geocarpa*). The last three do not thrive particularly well in the climate of Victoria, but give fairly satisfactory yields when sown at the end of the rainy season, so that they ripen during the dry season.

Cereals grown included maize, another important food plant. This was planted with good results at the end of the rainy season. Experiments in storing proved that the enclosed smoke house was the most satisfactory way to keep off the maize weevil (*Calandra oryzæ*).

Coffee cultivation was encouraged and several varieties were obtained from Java, one of which, *Coffea robusta*, has been extensively planted on the Missellele Estate.

Attention was also given to spices, and in the Victoria Botanical Gardens may be seen specimens or small trial plots of cloves, nutmegs, cinnamon, camphor, cardamon, vanilla and ginger.

Much of the experimental work of the Cameroons Agricultural Department was conducted on the privately owned estates which are to be offered for sale this year. A great deal of capital has been sunk in these properties, and the older established estates, as shown by the photographs, are very thoroughly equipped with buildings and machinery, including in some cases electric power plants and saw-mills.

Since the British occupation the system of voluntary labour has proved satisfactory, and a force of 10,000 to 12,000 men and boys has been maintained, and for future development purposes there should be no difficulty in obtaining labour at reasonable rates from the thickly populated districts of the adjoining protectorate of Nigeria.

The soil is chiefly of volcanic origin, and very fertile; the rainfall is well distributed, transport and shipping facilities are good. In addition to the crops now cultivated there are large tracts suitable for tobacco, sugar, bananas

and coconuts, and tea would thrive in the hills. The conditions of life generally are unrivalled in West Africa, and the country offers excellent opportunities to men of initiative, who have sufficient capital to engage in tropical agriculture.

The ex-enemy estates which, as a result of the war, have now come into the market are of various sizes and cover an area of over 300,000 acres, of which about 50,000 acres are under cultivation. Large tracts of the uncultivated area, especially in the Rio-del-Rey district, are well stocked with self-sown oil palms, and with comparatively small outlay of capital could be developed into properties of great value.

The sale takes place in London this year on October 11 and 12, and full particulars may be obtained from Messrs. Burchells, 5 The Sanctuary, Westminster, or from Messrs. Hampton & Sons, 20 St. James's Square, S.W.1.

The following particulars may be given relating to the illustrations accompanying this article.

Plate I, Fig. 1. *Bibundi Estate.*—Manager's house showing the landing stage and beach stores. Bibundi is situated on the sea coast about thirty miles north-west of Victoria.

Plate I, Fig. 2. *Tiko Banana Estate.*—Pier at Tiko built by the African Fruit Company, who, in 1913–14, opened up and planted a large area with bananas for export.

Plate II, Fig. 1. *West African Plantations, Victoria.*—Cocoa drying house and store at Bota. The rotary driers in the background are of British make.

Plate II, Fig. 2. *Moliwe Estate.*—Cocoa drying house. If there is sufficient sunshine the cocoa may be dried in the open, or the trays may be pushed in and the cocoa dried artificially during the rains.

Plate III, Fig. 1. *Mukonje Estate.*—Manager's house. This estate, which grows cocoa and rubber, is situated on the Mungo River about seventy miles north-east of Victoria.

Plate III, Fig. 2. *Mokundange Cocoa and Oil Palm Estate.*—Showing building containing machinery for expressing palm oil and preparing palm kernels for ship-

ment. This estate is on the sea coast about six miles west of Victoria.

Plate IV, Fig. 1. *Ekona Cocoa, Oil Palm and Rubber Estate.*—Showing mono rail system, electric switch station, and carpenter's workshop.

Plate IV, Fig. 2.—*Ekona Cocoa, Oil Palm and Rubber Estate.*—Interior of carpenter's workshop, fitted with electrically driven machinery.

GENERAL ARTICLES

COTTON GROWING IN TANGANYIKA

THE possibilities of Tanganyika as a cotton-producing country were demonstrated during the German occupation of that territory, and, in view of this, the Empire Cotton Growing Committee appointed Major H. Hastings Horne, C.B.E., to undertake a mission to Tanganyika in order to ascertain the present position of the industry and to report on its prospects. Major Horne accordingly made a tour of the country during the period November 1920—July 1921, and his Report, entitled "The Extension of Cotton Cultivation in Tanganyika Territory," has now been issued by the Empire Cotton Growing Corporation (London, 1922), and its salient features are summarised in the following pages.

In the introduction to the Report, Major Horne expresses his conviction that cotton can be established as the leading economic crop of Tanganyika, and can be made the means of bringing civilisation, comfort and even health to the people. To ensure these results, however, the work must be done thoroughly and carefully, and with a full appreciation of the uneducated condition of the natives. It is considered that during the early years the growers must be protected from loss due to inadequate prices. The extension of cotton growing and the consequent clearing of the wastes will doubtless render the country more healthy by reducing the prevalence of malaria. It is therefore recommended that the development of cotton

cultivation should be proceeded with as rapidly as the conditions permit.

The Report consists of three parts, viz. I. Descriptive; II. Critical and Constructive; and III. Miscellaneous. It contains as appendixes, (A) an extract from the report on the Morogoro District by Mr. Howe-Browne, (B) notes on cotton cultivation during the German occupation, and (C) a series of diagrams showing the average annual distribution of the rainfall at twenty different places in the Territory. A useful map is provided, showing the position of the cotton areas, the existing ginneries and the railways.

Part I. Descriptive

The areas of Tanganyika Territory recommended for cotton cultivation are (1) the Coastal Belt, (2) the Morogoro and Kilossa Region, and (3) the Lake Basin.

The Coastal Belt extends from British East Africa to Portuguese East Africa, and from the sea-level to an elevation of 600 feet. This area consists of flats, which are easily cleared, possess a rich soil and an adequate rainfall, and are bounded by rising ground providing an abundance of wood for fuel. In addition to the recognised harbours of Lindi, Kilwa Kisiwani, Tanga, Bagamoyo, Pangani, the mouth of the Rufiji River and Dar-es-Salaam, there are numerous creeks and inlets which afford safe harbourage for dhows. The Rufiji is navigable by light steamers for 80 miles from its mouth.

The Lindi District and the Kilwa Area have each a coast-line of 90 miles and a population of 395,000 and 96,000 respectively. The Rufiji District measures 100 by 150 miles, and has a population of 89,000. Dar-es-Salaam has a population of approximately 161,000. The Pangani area has a coast-line of 60 miles, and a population of 98,000. Bagamoyo has a coast-line of 50 miles, and a population which includes 15,000 adult males.

The native of the coastal belt is intelligent but not particularly industrious. He usually possesses a small coconut plantation and plants millet as a food-crop. In connection with cotton growing, supervision would be needed to keep him up to the mark; picking and weeding could be done by the women and children.

In general, the coastal belt possesses the drawbacks of a sparse population and the prevalence of malaria, but labour is obtainable within a reasonable distance.

In Kilwa, cotton growing could be practised on most of the cultivable land, but, owing to transport difficulties, it should at present be confined to areas near the coast.

In Lindi, cotton could be grown by the natives, but is not likely to be profitable on European plantations. Transport is available by means of a light railway which runs through the fertile Lukuledi Valley. A ginnery could be erected at Mahiwa, situated on the railway at a point 50 miles from Lindi, and worked by water-power. Excellent cotton of an Egyptian variety has been produced at Lindi.

The Rufiji Valley is said to contain some of the finest cotton land in the world. The flats on the banks of the river are easily cleared and are suitable for the employment of steam ploughs and improved cultivating machinery. The country is recommended for development by European capital, and although the climate is at present unhealthy it could doubtless be greatly improved by clearing the jungle and cultivating the soil. Adequate labour is available for working the estates formerly owned by Germans, and if, on extending the industry, local labour should prove insufficient, an abundant supply could be obtained from Mahenge, 120 miles distant. A considerable amount of cotton was planted in the Rufiji Valley in 1912 and 1913 and gave a large yield of fibre of good quality. It is probable that cotton could also be grown successfully as a native crop, for, although the Rufiji native is usually considered a poor worker, he would no doubt prove more efficient when planting on his own account.

The Morogoro and Kilossa Region, west of Dar-es-Salaam, extends for 90 miles along the Central Railway. It lies at altitudes of 1,000–3,000 feet, has an undulating character, a very rich soil, and is watered by three large rivers and numerous small streams. In Morogoro there are 30,000 families capable of planting cotton in suitable areas; 20,000 acres planted in 1921 were owned entirely by Greeks, Indians and Mission Stations. Kilossa is a

large area with a scattered population, including 50,000 adult males.

In this region planting by Europeans is not advisable except on irrigated lands, as the yield on non-irrigated land is too small to justify any large outlay. There are, however, large tracts suitable for cotton which could be irrigated without great expense. The country cannot be described as healthy, but German families have resided there continuously for five years. Transport is available to Dar-es-Salaam by the Central Railway. Labour is fairly plentiful, and additional workers could be procured from tribes living about two days' journey from the railway. It is recommended that encouragement should be given to the Greek settlers, as they are industrious farmers, and are able to handle native labourers in such a way as to get good work from them. The native should also be encouraged to grow cotton for the market. It is suggested that the Government Farm at Morogoro should undertake the provision of good seed and the training of native instructors.

Some of the best land in this region is situated near Turiani and Kissaki, which are respectively 35 and 65 miles from the railway. Owing to the tsetse fly, ox transport cannot be used, and it is therefore proposed that if cotton growing develops, ginneries might be erected at both these places, water-power being available in each case. The lint could then be conveyed by carriers to the railway and there baled.

The Lake Basin, comprising the districts on the Victoria Nyanza and the island of Ukerewe, lies at an elevation of nearly 4,000 feet and, being flat, is nearly all available for agriculture. The land in parts of this region is very rich and can be easily cleared, and the vicinity of the lake renders transport easy. The soil of the island is nearly as good as that of the mainland. The total population numbers 800,000, that of Ukerewe being 60,000. The Mwanza District has an area of 40,000 square miles, whilst that of the island is 300 square miles. A large part of the Mwanza District has a sufficient rainfall for cotton cultivation, but in the Tabora portion of the country the rainfall is uncertain, and irrigation

would be necessary. The natives are intelligent and industrious, but will require much attention and assistance during the first two years. It is considered that a staff of two Europeans and fifty native instructors could soon ensure large returns from the area with an adequate rainfall. The Mwanza District is recommended as one of the most favourable fields for the development of a native cotton-growing industry.

In addition to the three main districts mentioned above, reference is made to the *Tanga Railway Area* as offering good possibilities. Cotton planting has already been carried out to some extent in this region, but the data available are insufficient to warrant definite conclusions as to the prospects. Transport can be effected by railway to either Tanga or Mombasa.

Part II. Critical and Constructive

The Agricultural Department has scarcely yet been formed, and on account of the large numbers of German plantations (rubber, Sisal hemp, coffee and cotton) now for sale, the staff will probably be fully occupied for some time. It is considered that the interests of cotton could best be served by a separate branch of the Department which would be chiefly concerned with native cotton cultivation, as cotton planting by Europeans is not anticipated, except on the Rufiji River, in the Morogoro area, and perhaps on the Tanga Railway.

It is suggested that the Director of Cotton Cultivation should be subordinate to the Director of Agriculture, and that his staff should consist of two senior and five junior European assistants and 125 native instructors. It is pointed out that the co-operation of the District Commissioners with the cotton staff will be necessary to ensure success in the wide extension of the industry. It should be the duty of the cotton officers to see that the fields are planted at the proper season, to distribute seed for sowing, and to give instruction as to the methods of sowing and cultivation. Advice should be afforded regarding the marketing of the crop, and inspection undertaken to ensure that the plants are uprooted and burned after picking has been finished. The native is not likely

to grow cotton in two consecutive years on the same ground, and, if a change of crop is insisted on, the danger from disease will be minimised. In most districts it is unlikely that distribution of seed to the natives will lead to the production of a satisfactory crop until European instructors and native assistants are available to give help and advice. It is considered that, with the exception of the head of the cotton staff, suitable European assistants could be obtained from Uganda and Kenya Colony; a knowledge of the language and customs of the natives would be of great advantage in their work. It is further suggested that from each district a number of young men should be sent to Uganda to be trained; other instructors could be trained locally. The provision of bicycles would enable the instructors to visit a large number of plantations daily, and would thus prove an economy. The head cotton instructor should be provided with a sea-going launch, as there is no road following the coast-line, and such a launch would be invaluable if the Rufiji River area is to be developed.

The experimental stations established by the German Government at Lindi, Kilossa, and on the Rufiji River for the production of cotton seed should be re-started. The Mwanza District, however, is at present best supplied with seed from Uganda.

Greek planters aver that Egyptian cotton is the best for the Lindi area, and gives a heavier yield and a fibre of greater length than are secured in Egypt. The establishment of an experimental cotton station at Lindi would doubtless be a profitable investment. The Government should exercise strict control over theseed used for planting, and none but specially selected seed should be allowed to be sown. Moreover, cotton seed should not be issued except in places where adequate ginning facilities are available in the vicinity. It is recommended that the Cotton Department should undertake experiments with Egyptian cotton in the coastal area at Sadani, in the Rufiji area, and at Kilwa and Lindi.

The present methods of cultivation could be improved by the introduction of good English hoes to replace the primitive native implements which, owing to their light-

ness and fragility, cannot break up the dry, hard soil to any depth. Axes and bush knives would also be of value for facilitating the clearing of new lands. The more progressive natives could easily be persuaded to use light ploughs drawn by oxen.

With regard to scientific research, it is mentioned that the important Government farm and laboratory at Amani, established by German enterprise, are at present hopelessly under-manned, but a movement is on foot to render Amani a highly staffed institute for both Tanganyika and Kenya Colony, both countries contributing to its support. In addition to the German experimental cotton stations already mentioned, there is a Government farm at Morogoro, irrigated throughout and provided with buildings, and another at Mpanganya, fifty miles up the Rufiji River. These farms would be of great value for experimental cultivation, research and education.

The cotton areas which have been described are all well provided with transport facilities, and these, in conjunction with the steamers on Lake Nyanza forming a link with the Uganda Railway, will be adequate for the needs of the first few years. When planting is being steadily extended beyond the sphere of the existing lines of communication, motor-lorries, roads and bridges will be required.

The Coastal Belt, except in one or two instances, does not need roads at present, as there is no large population far from the coast, and it is amply provided with harbours, bays, inlets and rivers. A light railway, extending 80 miles from Lindi, opens up a very large cotton area, and is now being repaired by the Government. The Rufiji River is navigable for 80 miles by a 200-ton paddle steamer, and beyond this point canoes can be used during part of the year.

The Morogoro and Kilossa area, as already stated, is served by the Central Railway which runs from Dar-es-Salaam through Tabora to Lake Tanganyika. This area has produced excellent cotton, and it is anticipated that 10,000 bales could be grown by the natives and a further 10,000 bales by Greeks and others. The Turiani area is 40 miles from the railway, but if a ginnery was established

on the Mwami River cotton could be transported by motor-lorries without difficulty during seven months of the year. The road to Rufiji should be kept in repair and a number of bridges will be required, of which the only one involving any great expense is that which would have to be constructed across the Mwami River to connect Turiani with Morogoro.

In the Mwanza area a military motor road has been made to Shinyanga, and at comparatively small cost this could be rendered suitable for motor or ox transport for seven months of the year. Other roads could be made without much expense from such points on the Lake as Musoma and Shirati. In the Lake area, cotton is transported to Kisumu by steamers and thence to the coast by the Uganda Railway. Roads will be needed to the ginneries (see page 181), but the construction and upkeep of these will not entail a great outlay, provided that the roads are not used at the height of the rainy season.

The Tanga area is provided with the Tanga Railway, which can convey the cotton to Tanga Port.

The question of grading the cotton in the case of a newly formed industry presents several difficulties. The natives could, no doubt, soon be taught to grade their produce if an adequate cotton staff were available for the purpose. Promiscuous buying by Indian traders is sure to cause trouble, but this could be largely obviated by the establishment of cotton markets with properly supervised grading clerks. As long as the ginneries are in reputable hands, however, the grading could safely be done there; but it is necessary that the Government should exercise the greatest care in issuing licences to ginneries, and such licences should be withdrawn in the case of dishonest practices being detected.

Ginneries were erected by the Germans in all the areas dealt with in the Report. Many of these were seriously damaged during the military occupation, but a number have now been leased and are busily working. It is believed that Messrs. Bird & Co. will supply all the ginneries needed on the coast. They have already erected a first-class ginnery at Lindi and another at Dar-es-Salaam, and are prepared to establish others as the need may arise.

Five ginneries are now at work on the Central Railway, and, as this area possesses men of capital and intelligence, others will doubtless be erected when required. In the Lake Basin there is at present only one ginnery, but the size of the area renders it necessary that several more should be provided. It is recommended that ginneries should be erected at Shirati and Musoma on the Lake. In Ukerewe Island the Roman Catholic Mission has a small ginnery, but this would be quite inadequate if cotton-growing were taken up on any large scale. There is a similar small ginnery at the Holy Ghost Mission Station at Bagamoyo, and additional gins will probably be required here also. It is considered that, from the standpoint of native production, a number of small ginneries, well dispersed, would be preferable to large central ginneries, as the natives cannot be expected to carry their seed-cotton for long distances.

Much pioneer work in cotton growing in Tanganyika has been done by the Greek planters, many of whom have had experience in Egypt and apparently prefer cotton to any other crop. It is suggested that valuable assistance could be rendered by District Commissioners, stationed in districts remote from the existing transport routes, by making experiments on half-acre plots and sending a report on the results, together with samples of the cotton, to the Cotton Department.

It is stated that Major Russell, who has had sixteen years' experience in Tanganyika, recommends that in newly-formed Sisal plantations cotton should be grown during the first two years between the Sisal hemp plants. The cotton crop thus secured meets the expense of clearing the land and the Sisal hemp plants are not injured in any way by this practice. Heavy yields of cotton have been obtained by this means, which has met with very favourable reports from Manchester.

The suggestion is made that bonuses should be given to responsible Chiefs and Headmen who directly stimulate cotton growing in the whole of their area. The question of guaranteeing a fixed price to the natives for their cotton is discussed, and it is considered that, while such a course is quite necessary in the early stages of the indus-

try, the price guaranteed should be low and the natives should be told by the instructors that they must regard such a figure as normal, any higher price they may receive being considered as a piece of good fortune. The varying nature of prices should be explained to them, and they should be taught to estimate profits by averaging prices over a term of years. The whole question of being able to pay the native a fair price with little risk depends on economy of ginning and handling ; lower freight rates and cheaper money will also help.

All land in Tanganyika Territory is regarded as the property of the natives and can only be alienated by an Act of the Government. The only land which can at present be acquired by Europeans is the formerly German-owned plantations. These include some excellent cotton areas, and many of them are freehold.

The opinion is expressed that the Government should interfere as little as possible with the activities of the middlemen. Whilst itinerant buying is deprecated, it is thought that it would be injudicious to prevent legitimate Indian traders from buying cotton if brought direct to their shops. A cotton licence at a high figure would deter any but the larger merchants from securing one. In places away from the coastal belt buying centres should be established and cotton should be bought only at such recognised markets.

The crops likely to compete with cotton in Tanganyika are mtama, a sorghum or millet, which is the chief food crop in some districts, and simsim or sesamum seed. It is shown, however, that cotton would generally be more profitable than either of these products.

There are two districts in which re-population is needed. These are (1) the lands at the foot of Kilimanjaro, and (2) the Rufiji River district. Both these areas possess excellent cotton soil, but they are malarious. Experience gained in other localities has shown that only by a close form of cultivation can these areas be rendered healthy.

Part III. Miscellaneous

Referring to the Imperial aspects of cotton, emphasis is laid on the fact that, apart from the importance of

augmenting the Empire's production of cotton, the industry will result in a large increase in imports. After deducting the Government taxes, the greater part of the money received by the native for his cotton is spent on clothing, hoes, enamel ware, boots, lamps, etc., and the stimulation of such needs is of direct benefit to the country.

The quantity of cotton producible in Tanganyika Territory cannot at present be estimated. During 1921 it was anticipated that about 7,500 bales would be produced, and seeing that in this case there was no direct encouragement nor even an adequate Agricultural Department, it is difficult to forecast the result which could be achieved by Government propaganda and the assistance of competent instructors; a substantial increase, however, may be confidently expected. Good transport facilities, a large population and suitable soil are all available, and the only serious difficulty is the irregularity of the rainfall in certain areas. The rainfall statistics given in the appendix to the Report indicate, however, that when cotton is planted at the right time of the year there will be very few failures.

The need for a large and sympathetic Cotton Department is illustrated by the following facts. The native is accustomed to crops requiring only 90–120 days, and cotton would therefore make a much greater demand on his time; unginned cotton involves some trouble in connection with transport, and unless prices are good or a ginnery is situated near his fields the native is reluctant to undertake the labour; the fluctuation in cotton prices is not at present intelligible to the unsophisticated native; and cotton is the only crop which is subject to Government control and inspection. On all these matters the native requires careful instruction and sympathetic treatment.

The only districts dealt with in the Report are those which possess transport facilities, but there are other areas, such as Songea and Mahenge, which are well populated and could produce cotton if railway communication was provided.

In concluding his Report, Major Horne records his conviction that Tanganyika Teritory could become one of the largest producers of cotton in the Empire, provided

that the industry receives the hearty co-operation of the Government, is supplied with a large and sympathetic Cotton Department, and is protected in some way against loss due to violent falls in market prices. In the absence of these conditions, however, progress would be slow and the outlook uncertain. The expenditure recommended in the Report would suffice to establish the industry on a permanent basis, but delay would materially reduce the prospects of success owing to the possible occurrence of labour complications.

COTTON GROWING IN NYASALAND

DURING the months of June, July and August, 1921, a tour of the Nyasaland Protectorate was undertaken by Mr. H. C. Sampson, B.Sc., C.I.E., Director of Agriculture, Madras, on behalf of the Empire Cotton Growing Corporation, and his report has now been published by the Corporation under the title of *The Existing Conditions of Cotton Cultivation in Nyasaland and Suggestions for their Improvement.* A summary of this interesting report is given in the following pages.

After a brief description of the physical features of the country, attention is drawn to the question of transport facilities. Although vast areas are well adapted for cotton growing in respect of soil, climate and population, the area at present cultivated is greatly restricted owing to the high cost of transport to the railway, which hardly touches the cotton districts except in the low country, where transport is already available by river. Port Herald is connected with the Zambesi by a railway which runs due south to Chindio, and a line is now being built from the opposite bank of the Zambesi to Beira. Northwards from Port Herald the railway proceeds to Chiromo and thence ascends the Shire Highlands to Blantyre at an altitude of about 4,000 feet. All the cotton, except that grown in the low country, must therefore be carried up-hill to the railway and then down to the Zambesi by rail. It is proposed to construct a line from Luchenza on the existing railway (about 2,500 feet above sea-level) along

the plateau to the east of the Shire Highlands to Fort Johnston at the southern end of the lake. This, however, will not be effective in opening up the Shire Valley and the land to the west of it.

Cotton can be grown almost anywhere in Nyasaland between elevations of 100 and 3,000 feet, but the conditions at different levels vary so greatly as to render the problems connected with the cultivation much more complex than in most other cotton-growing countries. In all cases the seed is sown during the warm weather, which coincides with the rainy season, and the crop ripens as the weather becomes drier and cooler. At the higher altitudes the cotton is planted early, usually in November or December, but as the elevation decreases the sowing season becomes later until at the extreme south, in the Port Herald district, the seed is now usually sown as late as March. The lateness of the sowing in the latter district, however, involves considerable risk, as the cotton is entirely dependent on the late rains, and if these fail the crop is ruined. The safest areas appear to be those lying between elevations of 1,000 and 2,000 feet, and it is in this region that the industry is most likely to extend. The chief of these areas are the Upper Shire, West Shire and South Nyasa. The principal obstacles to such extension are the distance from the railway and the prevalence of the tsetse fly in certain districts.

The soils on the level lands within the area suitable for cotton cultivation are dark loams resembling the black cotton soils of India, but differing from these in texture owing to the presence of a much larger proportion of sand. A texture similar to that of the black cotton soils of India is shown, however, by soils in depressions of the country. Such soils are unsuitable for American cotton as aeration is lacking, and when heavy rains occur or the land is inundated the crop is a failure. The Ndinde Marsh in the Port Herald district is an example of such a soil, and although in a favourable season a good crop of cotton can be obtained, the risk of loss is too great for the cultivation to be recommended. Above the level of the plain the soil changes to a red earth, which in some cases is too shallow for continued planting.

The same methods of cultivation are practised both by the natives and by European planters, but the latter are generally more methodical and plant on straight ridges, whereas the natives often sow the seed on heaps of soil. In regions which are free from the tsetse fly, cattle are sometimes kept and are used for ploughing; but usually after the land has been cleared it is dug over with the native hoe. In some cases the whole area is hoed, but in other cases it is only dug in parallel strips, about 4 feet apart. These strips form the lines on which the cotton seed is sown, any loose soil being scraped on to them to form the ridges. The seed is dibbled in by hand at intervals along the ridges. When the plants are about 9 inches high, they are thinned out, leaving two at each place. After the crop has been gathered, the plants are either uprooted or cut off below the surface with the hoe.

The method of dibbling in the seed is objectionable for several reasons, and it is considered that it would be much more satisfactory to sow by means of a drill. The seeds could thus be sown much more regularly and evenly, the seedlings would have a better chance of developing, and thinning would be greatly facilitated so as to leave only the best plants and to cause little or no disturbance to their root-system.

The Nyasaland custom of planting on ridges has certain disadvantages as compared with flat cultivation as practised in India. The latter method enables hoeing and weeding to be performed more expeditiously, is less expensive, and reduces the loss of moisture from the soil as a smaller surface is exposed to the wind and sun. Moreover, the roots of the plants can spread equally in all directions, whereas in ridge cultivation they are largely confined to the ridge.

It is estimated that about 80 per cent. of the total area devoted to cotton in Nyasaland is under European management. As a rule, the planter who cultivates cotton grows little or nothing else, and a proper rotation of crops is never practised. Much more importance is attached to the size of the area than to the yield per acre, with the result that cultivation is not carried out with sufficient care, the crop receives inadequate attention, the

time of sowing is sometimes extended far beyond the period at which a remunerative return can be obtained for the expenditure and labour involved, and difficulty is often experienced in arranging for the necessary labour at critical periods of growth. The crop therefore becomes unhealthy and more liable to attack by pests and diseases.

The non-observance of a rotation of crops prevents proper cultivation and manuring and diminishes the fertility of the soil. When imported labour is employed, a small area of cereals or pulses is sometimes grown, but never with a sufficient production to feed the labourers throughout the year. If a cereal is grown, it occupies the ground for four to four and a half months of the rainy season. After it has been harvested, there is still enough moisture in the soil to admit of thorough and deep cultivation. The land will then lie under a plough fallow for seven to eight months, until the next crop of cotton is sown, and the weathering of the soil will increase its fertility as well as allowing for the more even distribution of water during the following cotton season.

Cotton is never manured in Nyasaland even where cattle are kept, and it is considered doubtful whether the direct application of manure would benefit the crop. If, however, a cereal or a pulse were grown in rotation with the cotton, crushed cotton seed might serve as a valuable manure for the former crop and would help to maintain the fertility of the soil.

The cotton bolls are usually allowed to open fully before picking is commenced. The cotton is not gathered until the sun is well up and the dew has evaporated. The bracts are therefore very brittle when the cotton is picked and, in consequence, the crop is liable to contain a good deal of "leaf." Grading is sometimes done in the field and sometimes subsequently. In the former case, the pickers each carry two bags, into one of which they place the clean undamaged cotton and in the other the stained cotton. In the latter case, the cotton is all put into one bag and is afterwards separated into stained and unstained by a distinct set of workers, usually children. Grade I consists of the clean, unstained cotton from which the "leaf" has been picked out, whilst Grade II is the stained

cotton and cotton attacked by boll-worm. Grade III is composed of immature cotton, much of which has failed to ripen owing to disease, and is generally badly stained.

The grading is best done in the field if sufficient labour is available, but as labour is usually scarce at the picking season it is generally preferable to grade afterwards, since the cotton should be gathered as soon as the bolls have burst or it is liable to become dirty and weathered and to lose its lustre.

It is evident that, under the present system of grading, there may be great variation in the cotton classed as Grade I by different growers, according as it has been obtained from a healthy or from a diseased crop or from an early or a late sown crop. This difficulty could be overcome by the establishment of an official grading scheme in which the seed-cotton would be graded by an expert at the ginneries. Such an officer would have to devote his whole time during the ginning season in travelling from one ginnery to another. All the gins should be registered and should be inspected, as much damage is often caused by bad ginning. Such a scheme would be of great value to the industry, as definite standards would be created, which would become recognised in the European markets, and the cotton would therefore obtain steadier markets and would realise better prices.

As already pointed out, the extension of cotton growing in Nyasaland is limited by transport difficulties. With regard to internal transport, more and better roads are needed. The cotton is mostly conveyed by carriers at a cost of ¼*d.* to ½*d.* for a head-load of 60 lb. per 100 miles ; but recently some growers have been using hand-carts. These seem likely to be useful, but better grading of the roads is necessary if their employment is to become general. Ox-wagon transport is possible in districts which are free from the tsetse fly, but this was stopped a short time ago owing to outbreaks of East Coast fever. Motor lorries have recently been used to some extent, but owing to the heavy cost of petrol, tyres, etc., this method of transport costs about twice as much as the employment of carriers. The great expense of road transport renders it necessary for the cotton to be ginned as near as possible

to the place where it is grown, and there is therefore a tendency for the multiplication of small ginneries instead of the establishment of large factories, which are generally both more efficient and more economical. Standard designs for ginning factories are needed in Nyasaland, as it is evident that the existing ginneries have been erected without sufficient knowledge of the requirements. The British Cotton Growing Association's factory at Port Herald charges £11 per ton for ginning and baling, which is equivalent to more than 1*d.* per lb., whilst some of the up-country ginneries charge even higher rates. In the present state of the industry such charges are too high, and it is suggested that the Empire Cotton Growing Corporation might consider the possibility of subsidising all gins and presses which work at a reduced rate.

With regard to external transport, the railway rate from Limbe (near Blantyre) to Chindio on the Zambesi is ½*d.* per lb. To this must be added the river steamer freight from Chindio to Chinde, the sea freight from Chinde to Beira and the ocean freight from Beira to Europe. The pre-war freight from Beira to England was about £4 14*s.* per ton, which is less than the present rail charges on the Nyasaland railways alone.

The cotton crop of Nyasaland is attacked by several insect pests, including the red boll-worm (*Diparopsis castanea*), the Egyptian boll-worm (*Earias insulana*), the American boll-worm (*Chloridea obsoleta*), aphis, leaf hoppers and cotton stainers. The red boll-worm is the most destructive of these pests; in order to effect its control the Agricultural Department recommends (1) the collection by hand and destruction of the caterpillars when they first make their appearance, and (2) the enforcement of the ordinance which requires the cotton stalks to be uprooted and burned by a given date after the picking has been completed.

The most serious disease of cotton in Nyasaland is that known as boll-rot; it is much more prevalent in some seasons than in others, and appears to be increased by unfavourable conditions of growth.

The regular cultivation of cotton as a native crop has not yet become fully established. The native is not a

good cultivator, will not grow more than is needed to meet his actual requirements, and is easily discouraged. The only implement used is the hoe, and the crops are commonly choked with weeds. In the low country, cotton is frequently sown as a second crop on land on which a grain crop has been produced.

As the areas best suited to cotton are in the less temperate parts of the country which are unsuitable for the permanent residence of Europeans, it is anticipated that cotton growing will eventually pass entirely into the hands of the natives whilst the Europeans will attend to the handling and export of the crop. As already stated, however, at the present time about 80 per cent. of the cotton is grown by Europeans under plantation conditions.

Although the Government have rightly encouraged the cultivation of the crop by the natives, they have rather neglected the European planters. For example, seed has always been supplied to the natives free of charge, but only very rarely has seed produced at the Agricultural Stations been made available for planters and, even in such cases, only for purchase. The planters have therefore been compelled to obtain seed for themselves, and a number of different varieties of Upland cottons have thus been introduced and, in consequence, the crop frequently consists of a mixture of various kinds. The cotton therefore lacks uniformity, the staple varies in length from ¾ in. to 1½ in. and in some plants is fine and silky and in others coarse and harsh.

There is, however, plenty of good cotton in the country if only it could be obtained in a state of purity. A number of plants have now been selected and several samples of seed have been set aside for further propagation. The results of the preliminary plant selections are given in an appendix to the *Report*. It is pointed out that co-operation is needed between the Agricultural Department and reliable planters for the multiplication of seed of proved types in order to standardise the crop.

The supply of labour in Nyasaland was formerly abundant and cheap, but it now costs about twice as much as before the war. The influx of new settlers has

created a shortage of labour which is partly due to the inefficient use made of it and partly to the lack of enterprise on the part of the labourer himself. Work is done on the "task" system, by which a certain task is set to all labourers alike, and there is no incentive to do any more than this. There is no doubt that labour could be rendered more efficient if hand implements were improved and if bullock-power implements were more adapted to the needs of the country.

With regard to the Agricultural Department, it is stated that the only officer who had had any experience of tropical agriculture before proceeding to Nyasaland is the Director of Agriculture himself, and it is suggested that new officers should be sent to India for a year's training before taking up their duties in the Protectorate. The existing Agricultural Stations are considered to be too large and the lines of work too diffuse for the accomplishment of valuable results. There are two such stations in the country, one near Port Herald and the other near Zomba. The former is inaccessible, unhealthy and of little or no value for cotton work. The Zomba station will be useful for studying cotton at the higher elevations, but more work is attempted at present than the small staff can adequately carry out and experiments cannot receive the necessary attention. In the past, selection work has been done at this station, and different varieties have been tested and compared, but at present the only work being conducted is the multiplication of seed of the strains produced in former years which now have apparently become hopelessly mixed.

It is recommended that small sub-stations should be started by the Department of Agriculture at places representative of the different zones in which cotton is grown, and that these should be under the control of a cotton specialist. It would probably be possible to obtain the co-operation of planters so that a reliable grower would undertake the supervision of the station and would ensure that the cotton officer's instructions were carried out by the native overseer. The work of such stations would at first be restricted to growing and comparing unit strains of cotton, but could afterwards be used for local

demonstration of the results obtained at the larger experiment stations.

The *Report* contains a useful map of the southern part of Nyasaland.

REGULATIONS REGARDING COTTON PESTS AND DISEASES IN BRITISH COLONIES AND INDIA

In several of the British Colonies and in India special legislation has been enacted with a view to safeguarding the cotton crop against the attack of insect and fungoid pests. In some places, however, where cotton is grown on an extensive scale, it has not yet been considered necessary for any measures to be framed for its protection. Apparently no attempt has hitherto been made to give a general account of the administrative steps undertaken by the different countries of the Empire with regard to this matter, and the present article, representing the results of enquiries made by the Imperial Institute, has therefore been prepared.

The kind of cotton grown in any particular locality is so greatly dependent on climate and geographical position, that practically each country has come to possess its own peculiar regulations. These are often, especially in the case of insect pests, designed to prevent too close a communication with near neighbours; the necessity for which may be illustrated by the case of the pink boll-worm. In 1910 this insect pest was known to exist in India, German East Africa, British West Africa and Hawaii; by 1921 it was recognised in Egypt and the Sudan, Mesopotamia, Brazil, Peru, Mexico, the United States and the West Indies. In fact, almost every country growing cotton had been invaded by it, with the exception perhaps of Turkestan, Uganda, Nyasaland and South Africa. The spread of the pest was chiefly due to the transport of infected cotton seed, often contained in bales of ginned cotton, and has necessitated legislation, which in nearly every case has unfortunately been effected rather too late to secure freedom from attack.

The relative importance of the various countries of the

Empire as producers of cotton is indicated in the following table. In the case of India the figures show the official estimate of production in 1920–21; those for the remaining countries are taken from the *Annual Report* of the British Cotton Growing Association for the calendar year 1921 and represent the estimated output for that year.

	Bales of 400 lb.	
India:		
Bombay (including Sind)	969,000	
Punjab	588,000	
Central Provinces and Berar	514,000	
Madras	358,000	
United Provinces	337,000	
Burma	42,000	
Bengal	21,000	
Bihar and Orissa	15,000	
Assam	15,000	
		2,859,000
Other Provinces and States		742,000
		3,601,000
Uganda	81,300	
Anglo-Egyptian Sudan	27,700	
Nigeria (Southern Provinces)	19,500	
Nigeria (Northern Provinces)	12,000	
Tanganyika Territory	7,500	
West Indies	4,500	
Nyasaland and Rhodesia	4,600	
South Africa	2,500	
Kenya Colony	500	
Other Countries	5,000	
		165,100
		3,766,100

India

Bombay.—In spite of the fact that 5,688,000 acres were planted in 1920–21 against 5,857,000 in the previous year, the crop was 38 lb. per acre below that of 1919–20, the actual reduction being from 103 to 65 lb. The chief reason for this deterioration is said to be shortage of rainfall, while the local Coompta cotton is reported to have been damaged by insects and the Dharwar-American by red-leaf disease. The only regulation respecting cotton in this Presidency is Act II of 1914, the short title of which is "The Destructive Insects and Pests Act, 1914." By this Act the Governor-General in Council has the power of regulating or prohibiting the import of material likely to carry infection. Under the powers given by this Act,

the Governor-General in Council issued the following order on November 7, 1917, No. 13-c, with reference to cotton: "Para. 8. Seeds of coffee, flax, bersim and cotton shall not be imported by land or by sea, by letter or sample post"; and in the same order: "Para. 11. Cotton seeds shall not be imported by sea except after fumigation with carbon bisulphide and at a prescribed port." There follows a schedule giving a list of the countries of origin and the authorities in those countries from whom it is necessary to procure a certificate of fumigation. No other regulation is apparently in operation. The object of the restriction is to prevent the introduction of new pests and diseases from abroad, while no regulation is imposed regarding the pests already in the country.

Punjab.—The area under cotton in this Province in 1920-21 was 2,142,000 acres against 2,269,000 in the previous year, but the crop per acre fell from 120 lb. to 110 lb. No regulations of any kind are in force in the Punjab, although it is understood that serious damage (5 to 10 per cent.) is sometimes caused by the cotton boll-worm.

Central Provinces and Berar.—The area devoted to cotton in this Province in 1920-21 is stated to be 4,477,000 acres as against 4,600,000 in the previous year. The yield per acre fell from 112 to 46 lb., and the total crop, which is normally about double that of the Punjab, was 74,000 bales of 400 lb. less than that of the latter Province during the year under consideration. The conditions were reported as most unsatisfactory, owing mainly to a failure of the rainy season. The Central Provinces furnish a little over a third of the area stated, 3,076,000 acres being represented in Berar. There are no regulations relating to the control of pests in force in the Presidency.

Madras.—The latest estimate of the cotton crop in Madras shows that 2,151,000 acres were sown in 1920-21, against 2,339,000 in 1919-20. In the main Northern and Western areas, the lack of rain has been severely felt and the crop from those districts has been largely a failure. In the Cambodia area the conditions were better and a fair crop was expected. The Tinnevelly crop was reported to be slightly damaged by late rain and the season was found generally to be a late one, but the yield was expected

to be about normal. This was estimated for the whole Presidency at 67 lb. per acre against 70 lb. in the previous year. By Act No. III of 1919, which is termed "The Madras Agricultural Pests and Diseases Act, 1919," and which was promulgated on April 29, 1919, the Governor is empowered to make certain rules regarding the protection of plants growing in the country, and in exercise of this he directs that all Cambodia cotton plants in certain specified districts be pulled completely out of the ground and allowed to wither before August 1 in each year. The reason for this notification was that the stem weevil (*Pempheres affinis*) and the pink boll-worm (*Gelechia gossypiella*) were established as pests in respect to Cambodia cotton. This effect was brought about by the fact that Cambodia cotton was treated as a biennial or perennial crop, and had thus favoured the spread of the two insect pests, which have now become serious. It is therefore proposed to limit the cultivation of this as well as all other cottons to a single year, and to arrange for a certain close time, during which there will be no cotton growing.

United Provinces.—The cotton area in this Province was 1,161,000 acres in 1920–21 as against 1,268,000 acres in 1919–20, the crop producing 116 lb. per acre as against 138 lb. in the previous year. The season was very unsatisfactory, and the crop, which is usually a large one, suffered from the abnormal shortage of rain. No regulations with respect to cotton are at present in force in these Provinces.

Burma.—There was a decline in the area planted in Burma during 1920–21, viz. 376,000 acres as compared with 430,000 acres in 1919–20, and the yield per acre fell from 83 lb. to 46 lb. It is reported that the crop was severely affected by lack of rain, and the very scanty production of 42,000 bales is indicative of this condition. The only regulation affecting cotton pests which is in operation in the country is the Government of India's Notification No. 13–c, dated November 7, 1917, by which under powers of Act II of 1914, the Governor-General in Council issued a general order, which is being observed in Burma at the present time, and which is fully explained under the heading of Bombay Presidency (page 194).

No other regulation appears to have been enforced in the country.

Bengal.—The area under cotton in this Presidency increased in 1920–21 to 71,000 acres, as compared with 69,000 acres in the previous year. The production is divided into early and late crops. The early cotton suffered during September and October when an excessive rainfall affected the outturn, whereas the late crop was quite satisfactory up to the first part of October, but was subjected to a drought in the latter part of the month which prevented the attainment of a good crop. The yield per acre in 1920–21 was estimated at 118 lb. against 145 lb. in the previous year. The area devoted to cotton in Bengal is negligible compared with the total area under cultivation, and there are no regulations in the Presidency controlling cotton pests and diseases.

Bihar and Orissa.—Cotton is a comparatively unimportant crop in this Province also. Exclusive of Orissa and Chota Nagpur Feudatory States, which report 51,000 acres and 11,000 bales in 1920–21, the area under cotton was 78,000 acres, identical with the area grown in 1919–20, whilst the crop was only 15,000 bales, as compared with 18,000 bales in the previous year. This represents a decline from 92 lb. to 77 lb. per acre in the season. Weather conditions in the early part of the season were generally favourable, but the drought from October to December affected the outturn in some districts. The only regulation in respect to the crop is that before cited (p. 194), viz. No. 13–c of November 7, 1917, under Act II of 1914, which only affects the importation of cotton seed.

Assam.—Cotton from this Province is confined to the coarse short-stapled Commillas, grown only in the hill districts. The inhabitants use their own seed and do not import. Hence Para. 11 of the Notification No. 13–c of November 7, 1917, issued by the Government of India (see p. 194) has no practical effect. There is no other regulation in Assam. The area in 1920–21 was 39,000 against 33,000 acres in the previous year, and the crop in the two years amounted to 15,000 bales and 13,000 bales respectively. The 1920–21 season was not considered a good one owing to climatic conditions being unfavourable.

Native States.—No special enquiry was made as to cotton regulations in the Native States, which supply a considerable portion of the Indian crop. No regulations, however, are at all likely to be enforced in these countries, and they are probably without any restriction with regard to cotton.

Uganda

The cotton crop of Uganda in 1921 was 81,300 bales of 400 lb. against 52,000 bales of the same weight in the previous season. An Ordinance, referred to as "The Uganda Cotton Amendment Ordinance, 1920," gives the following rules regarding (*a*) seed for sowing, and (*b*) uprooting of cotton plants ; the remainder of the Ordinance refers to licences for buying cotton, to ginneries, etc.

(*a*) Seed for sowing.

2. Cotton seed for sowing purposes shall be distributed by the Government at such times and places and by such persons as the Government shall prescribe.

3. No person shall grow cotton from seed which has been obtained from any other source than the Government.

4. The Director of Agriculture shall have the power to requisition any cotton seed considered suitable for sowing purposes, and such seed shall be handed over free of all costs.

5. All cotton seed obtained from hand cotton gins shall forthwith be destroyed by the person so obtaining, or by any person into whose possession or ownership such seed shall come.

Provided always that it shall not be necessary to destroy such seed pending its being supplied to the Government or exported or being treated in some manner which will prevent its being used as seed for sowing purposes. The burden of proof that such seed is to be so supplied, exported or treated shall be upon the person owning or possessing such seed.

(*b*) Uprooting of cotton plants.

6. All cotton plants shall be uprooted and detroyed after the first season's crop has been picked therefrom, and on no account shall they be allowed

to remain for a second season or for more than one year in the ground.

7. The Director of Agriculture may from time to time fix by notification in the *Gazette* a date prior to which all the previous season's cotton plants shall be uprooted and destroyed in any District, and all such plants shall be uprooted and destroyed prior to such date.

This Ordinance, which it is directed shall be read as one with the Uganda Cotton Ordinance, 1908, the Uganda Cotton (Amendment) Ordinance, 1910, and the Uganda Cotton Ordinance, 1920, came into force on the 1st day of January, 1921.

Anglo-Egyptian Sudan

The estimated crop in 1921 was 27,700 bales, nearly 6,000 more than the output of the previous year. In an *Agricultural Handbook*, published in 1920, all the Plant Diseases Ordinances, Regulations and Orders which have been in force since 1907 are given, and may be referred to here in the order in which they appear. Ordinance No. 7 of 1907 has reference to locust destruction, a most important regulation where young cotton is liable to be attacked. Where locusts have deposited their eggs in cotton lands, it is required that the land shall be worked with a " fass " as thoroughly as possible without uprooting the plants. The penalties for persons not observing the Ordinance vary, in accordance with the paragraph which has not been compiled with, from a fine not exceeding £2 or imprisonment not exceeding 30 days, or both, to a fine of £5 or imprisonment for a term not exceeding two months, or both.

Next in order is the Plants Diseases Ordinance of 1911, No. 3. By this Ordinance the Governor-General is given powers to proclaim diseases, order the destruction of diseased articles, detain imported plants in quarantine, co-operate with the postal and customs officials and generally to order in any other matters for which regulations are contemplated by this Ordinance. The diseases proclaimed by this Ordinance include the pink boll-worm (*Gelechia gossypiella*), which was added by notice published

in the Sudan Government *Gazette*, No. 315 of 1917. Another Order under the Plant Diseases Ordinance, 1911, published in the same *Gazette*, prohibits the transportation of cotton seed, seed-cotton, cotton lint, cotton plants, and any parts thereof, from the Red Sea Province into any other part of the Sudan, except by or under the authority of the Director of Agriculture. A further Order published in the *Gazette*, No. 340, dated December 5, 1918, prohibits the importation of growing plants into the Sudan, but allows the entry of such plants from Egypt under stringent conditions.

The Cotton Ordinance, 1912, was promulgated in November 1912. By this, importation of cotton seed, except under a permit granted by the Director of Agriculture, is prohibited; no cotton seed may be used for sowing unless it has been approved by the same authority or an Inspector of the Department; cotton shall be picked clean, free from leaves, bolls and dirt, and none but clean cotton shall be sold or offered for sale; no cotton is to remain on the land longer than one season. The remainder of the Ordinance refers to manipulation in ginning factories, etc., the regulation of the working of ginning factories and the protection of the health and safety of persons engaged therein. By the Cotton Regulations, 1913, issued under this Ordinance all cotton plants shall be destroyed in the following districts or provinces before the dates given in each year: Tokar, July 20; Berber or Khartoum, May 15; Kassala, June 15; and all cotton stalks north of Kabushia, Berber Province, shall be destroyed before April 30 and south of Kabushia before May 15. There is another paragraph in the Regulations referring to occupiers of cultivated land in the Tokar Plain being obliged to destroy all noxious weeds, such as "hambuk" and "ushur," and other plants likely to harbour pests on their land, the remainder of the regulations dealing chiefly with marketing and ginning cotton. In March 1917 Cotton Regulations were published to amend those of 1913. These gave the Director of Agriculture, with the consent of the Governors of the Provinces, permission to alter the date before which all cotton plants, stalks, bolls or parts of

plants shall be destroyed by the owner and occupier. They also regulated the removal or destruction of all waste cotton seed, etc., from a ginning factory likely to harbour the pink boll-worm, and made it only permissible to store cotton seed in a ginnery after ginning has been finished for the season, where the doorways, windows and other openings are covered by wire gauze-mesh sufficiently fine to contain the moth of the pink boll-worm, or in such a manner as the Director of Agriculture may approve.

The pink boll-worm having been found in Tokar cotton seed, it became urgent that steps should be taken to prevent seed-cotton or cotton seed grown in the Tokar district from being transported into the other districts, and great care is exercised in this matter.

Nigeria

The crop from this portion of West Africa is calculated at 31,500 bales for 1921, against 16,200 for the previous year. In 1916 an Agricultural Ordinance was promulgated to enable the Governor in Council to make regulations for the prevention of the introduction or spread of pests and insects destructive to plants and crops; for the control of cotton ginning and the preparation of cotton. Under this the Governor in Council may make regulations for any of the following purposes:

1. For preventing the introduction or spread of any insect, fungus or other pest destructive to agricultural crops.

2. Regulating the sowing, collecting, ginning or other preparation of cotton.

3. Prohibiting the importation or sowing of any particular kind of seed, or specifying any particular kind of seed as the only kind to be imported or used.

These are all clauses pertaining to the prevention of diseases in cotton. The Ordinance, which replaces the Cotton Proclamation and the Destructive Pests Ordinance of 1910, may be applied to the whole of Nigeria or any part thereof. By the regulations made under the Ordinance, No. 8 of 1917 enjoins that all cotton seed shall be imported through the Port of Lagos and that, unless it is covered by a certificate to the satisfaction of the

Director of Agriculture that it has been disinfected before shipment, he may disinfect it at the expense of the importer, or destroy it. In 1918 regulations were again introduced, No. 2 applying to the Northern Provinces only, and making it an offence to mix American with native cotton. By a Native Court rule of the Zaria Province dated October 30, 1916, in order to improve the quality of cotton grown in the Province, it is made a punishable offence to plant any but Government seed, or to mix cotton grown from Government seed with native cotton. A similar rule was made on July 22, 1920, in respect to the Court of the Sokoto Province. These rules seem to have little to do with the prevention of pests and fungi, but are practical guarantees that the seed is free from attack and that the crop is reasonably safe. By a Regulation, No. 18, 1920, an amendment was made of Regulation No. 8, 1917. By this the Governor shall from time to time declare what are the American cotton areas in which no other cotton may be cultivated, and except in such parts of the Provinces of Sokoto, Kano, Bornu and Yola as are not declared to be American cotton areas, the owner or occupier of any land in Nigeria on which cotton or any cultivated species of *Hibiscus* exists shall uproot and burn all the plants of either group, in the Northern Provinces before March 1, and in the Colony and Southern Provinces before April 1 in each year.

Gold Coast

Although no cotton is grown for export in the Gold Coast, it is possible that at some time it may again come into prominence. An Order in Council was made on April 20, 1912, regulating the importation of cotton seed into the Colony and requiring a certificate to the effect that disinfection had been carried out prior to shipment. The Director of Agriculture was empowered to destroy all cotton seed imported without such certificate or to direct its being landed at such place as he may choose to enable him to disinfect it at the expense of the importer.

West Indies

The chief cotton-growing islands of the West Indies are those generally known collectively as the Leeward

Islands, comprising Dominica, Antigua, Montserrat, Virgin Islands, St. Kitts and Nevis. During the year 1920 the pink boll-worm made its appearance in Montserrat and St. Kitts, and it is feared that the outbreak will result in some curtailment of the area under cotton cultivation. Of the Windward Islands, St. Vincent takes the lead in quantity and quality of cotton produced, Grenada following closely, with St. Lucia far behind. The estimated production for the West Indies in each of the years 1920 and 1921 was 4,500 bales, against 5,500 for 1919.

In the Leeward Islands the Governor made an Order in Council prohibiting the importation of cotton seed and seed-cotton into the Presidency of Antigua. This was dated December 9, 1920. In the Virgin Islands a Proclamation dated August 27, 1917, under the Virgin Islands Ordinance No. 3 of 1897, states that cotton seed or seed-cotton from all countries outside the Colony of the Leeward Islands, or from Grenada, St. Vincent, St. Lucia, Trinidad and Tobago, is prohibited from importation. This, by an Order in Council dated October 5, 1920, was amended and made exclusive for all places. In Montserrat, by the Cotton Ordinance, 1914, cotton plants are not permitted to remain in the soil longer than one season. By the Cotton Stainer Ordinance of August 22, 1918, all cotton growers are compelled to destroy the cotton stainer met with in or about any cotton store house, and a curator, inspector or other authorised person shall not be deemed trespassing by reason of any entry on to land where he has cause to suppose the cotton stainer exists. By Ordinance No. 7 of 1919, the Governor and Legislative Council of Montserrat repeal the Cotton Ordinance, 1914, and declare that the Governor in Council may from time to time, by proclamation published in the *Gazette*, declare any period of the year to be a close season for cotton, and that in every year the occupier of any land in the cotton district shall, before the first day of the close season, burn or bury any cotton plants on that land. The planting of cotton is prohibited during the close season. Inspectors or persons authorised by the Governor for carrying out the Ordinance, may destroy cotton plants found undestroyed by the beginning of the close season and recover expenses from the occupier.

In St. Kitts and Nevis an Ordinance No. 7 of 1918 (September 28, 1918) was made to provide for the eradication of the pest known as the cotton stainer. This is similar to the Cotton Stainer Ordinance of Montserrat dated August 22, 1918. By No. 8 of 1918, also dated September 28, a close-season date was fixed for three of the four districts of St. Kitts, leaving the fourth to be declared later by proclamation. The Governor is also empowered to fix the close seasons for the islands of Nevis and Anguilla by proclamation. By a Proclamation published in the *Gazette* of March 6, 1919, the close season was fixed for two divisions of Nevis. On October 25, 1917, the importation of cotton seed and seed-cotton was prohibited from any country or place outside the Colony of the Leeward Islands except Trinidad and Tobago and its Dependencies, and the Presidencies of Grenada, St. Vincent and St. Lucia.

A Cotton Stainer Ordinance No. 8 of 1919 (January 31, 1919) was promulgated with regard to the island of Antigua, and also one termed the Close Season Ordinance No. 10 of 1919. Both Ordinances are the same as those detailed for Montserrat; and the Proclamation under Antigua Act No. 4 of 1897, prohibiting the importation of cotton into the Presidency from all places outside the Colony of the Leeward Islands, was amended by the Order in Council previously referred to, dated December 9, 1920, which prohibited the importation of cotton seed or seed-cotton into the Presidency from any source whatever.

There is an Ordinance, No. 3 of 1911, providing for the destruction of old cotton plants, to prevent cotton being grown as a biennial plant in St. Vincent, and a Cotton Stainer Ordinance similar to that before mentioned, No. 16 of 1916, dated July 25, 1916. This was supplemented by No. 3 of 1918, by which the occupier of any building in the neighbourhood in which the cotton stainer is present is compelled to destroy the pest if it occurs within the building. On February 28, 1918, an Ordinance to amend the Cotton Diseases Prevention Ordinance of 1911 was enacted. It had reference to the planting of cotton outside the " cotton season " and the penalties to be imposed on anyone who plants cotton or causes it to be planted at any other

time than the period thus defined. By a notice published on July 30, 1917, the importation of seed-cotton or cotton seed from any country or place was prohibited, and by a similar notice the prohibition was extended to "lint cotton" packages, coverings and bags or other things which have been used as packages, coverings or bags for any cotton seed, lint cotton or seed-cotton, from any country or place.

Barbados at one time occupied an important position in the West Indies as a producer of cotton, but the amount grown has decreased considerably in recent years. By an Order issued in 1915 under the Trade Act, 1910, the importation of cotton seed from the United States, Colombia, Cuba, Mexico and Guatemala is prohibited except under a licence from the Governor. Cotton seed may be imported from Porto Rico provided it is accompanied by a certificate stating that the seed originated in that island and that the boll-weevil was not known to exist there at the time.

Nyasaland and Rhodesia

The crop from these two countries together amounted to 3,500 bales of 400 lb. in 1920 and 4,600 bales in 1921.

Under the Nyasaland Cotton Ordinance of 1910, rules were made which were published in the *Gazette* of the Colony on May 31, 1920. These relate to the destruction of cotton bushes in order to prevent their being grown for more than one season, and prohibit the distribution of cotton seed to natives which has not been approved by the Director of Agriculture. These conditions indicate the extent to which the rules can be said to apply to the prevention of disease.

Much less cotton is at present grown in Rhodesia, and the only regulations regarding the control of cotton pests and diseases is contained in Section 11 of the Government Notice No. 259 of 1913, by which no persons shall introduce cotton seed into Southern Rhodesia from any place outside British South Africa except by special permission of the Director of Agriculture, who may grant or withhold such permission at his discretion. No other rule appar-

ently has been found necessary to protect cotton growing in the country.

Union of South Africa

The estimated production for this country in 1921 was 2,500 bales. This is more than three times the crop of 1919, the industry having been encouraged by the system adopted by the British Cotton Growing Association of awarding prizes for competition among planters.

Agricultural pests are dealt with by Act No. 11 of 1911, under which a special permit is required to import cotton seed into the Union from overseas or from other than British territory in South Africa. It was decided in 1917 that permits should be given only in respect of seed intended for sowing and then only when the introduction of such seed was deemed desirable by the Chief of the Cotton Division. In a notice issued by the Secretary for Agriculture, No. 10, dated January 2, 1919, reference is made to the danger of importing unmanufactured cotton into the country, pointing out that such cotton often contains seeds which may unavoidably introduce a serious pest. A Proclamation was made on January 15, 1921, adding a prohibition of the importation of cotton seed with lint attached, and cotton lint in which any cotton seeds are contained.

East Africa (Kenya Colony)

Only a very small amount of cotton is produced in the Colony, chiefly owing to the high altitudes and heavy rainfall which render the country largely unfavourable to the cultivation of the cotton plant. The estimated crop in 1921 was 500 bales, against 100 bales in the previous year. No legislation is in force to protect cotton.

Tanganyika Territory

In Tanganyika, where about 7,500 bales of cotton were produced in 1921, there is an Ordinance, dated December 15, 1920, for the Regulation of the Cultivation and Sale of Cotton. That part of the Ordinance which refers to cultivation has a bearing on the prevention of disease.

It was enacted that the Governor may make rules "(6) for the inspection of cotton seed and cotton plantations and the eradication of diseases and insect pests." By the rules made under this Ordinance, no cotton seed shall be imported except by special licence obtained from the Director of Agriculture. The Director has also power to requisition and distribute seed from any plantation in the country, and no native shall be allowed to grow cotton from any seed which has not been approved by the Director of Agriculture. Everyone growing cotton shall give notice if he finds any disease or insect pest in his plantation, and specimens of the same must eventually be sent to the Director of Agriculture, who will advise and identify the specimens, besides recommending the necessary steps to be taken to deal with the matter. No cotton plant is to remain in the ground beyond the period of one year, and the Director of Agriculture may from time to time fix, by notification in the *Gazette*, a date prior to which all the previous season's cotton plants shall be uprooted and burnt. At any time the Director of Agriculture shall have access to any plantation where cotton is grown, and shall be at liberty to see that these or any other rules under this Ordinance are being complied with by the grower. When disease is found to exist in any plantation, the Director of Agriculture may order that all the cotton plants shall be burnt forthwith, that the plantation shall be deeply tilled and that cotton shall not be replanted prior to the expiration of two years from the completion of the tilling, and these and any other instructions that he may give must be complied with. The rest of the rules deal with the marketing of cotton.

Other Countries

Although 5,000 bales is the figure at which the production of other countries of the Empire is estimated in the British Cotton Growing Association's Report, it is perhaps rather high. The countries included under this total are Ceylon, Commonwealth of Australia, Territory of Papua, Fiji, Malta, and Cyprus. No legislation specially relating to diseases and pests of cotton is in

force in these countries, but in all of them Ordinances are in force relating to pests and diseases under which cotton may be protected.

FLAX MACHINERY

The attention which has been given in recent years to the question of an increased production of flax in several parts of the Empire, notably in Kenya Colony, Canada, Australia and also in the United Kingdom, has rendered it clear that the success of the industry from the point of view of the producer depends on the wider use of labour-saving machinery in nearly all stages of the cultivation and preparation of the fibre.

Apart from the question of the preparation of the land for the reception of the crop, in which motor implements must be employed as fully as in the case of ordinary arable farming, the principal phases in flax cultivation which afford scope for the introduction of machinery, or for the improvement of existing appliances, are the harvesting of the crop (" pulling "), the removal of the bolls from the flax plants (" de-seeding "), the " breaking " and " scutching " of the straw, and, finally, the crushing of the separated bolls to obtain the seed for sowing or other purposes. During the last few years several types of improved or entirely new machines for these various processes have been placed on the market, and particular attention has been paid to the design of a single machine planned to carry out the breaking and scutching processes consecutively. In the present article it is proposed to give an account of a number of flax machines which are now on the market.

The methods of harvesting and preparing the fibre at present in vogue may be first described. Short reference was made to these methods in an article on the cultivation and production of flax published in this Bulletin (1911, 9, 355), but it will be useful here to refer more fully to the subject.

The first process in the winning of flax is the " pulling " of the plants from the field. To be well pulled, the flax

should be free from all weeds and second growth, and the stalks of the straw must be kept straight and unentangled. Hitherto, the work has been done by hand, and although the labour employed is not skilled labour, pulling must be carefully done by people thoroughly acquainted with the crop. The process, however, is mainly a question of labour, and offers considerable field for the ingenuity of the engineer in designing satisfactory machines for the work. The subsequent " de-seeding " of the pulled flax, in which process the bolls are stripped from the branches, is an important operation which until comparatively recently has also been carried out by hand. Considerable skill is required to prevent the straw from becoming tangled or bruised and to avoid injury to the bolls and seed, and a satisfactory machine for this process has for long been a desideratum. The separated bolls are collected and later carefully crushed in order to obtain the flax seed (linseed). The pulled and de-seeded straw is subjected to retting, a process to which it is not proposed to make further reference in this article. Scutching (preceded by the crimping or " breaking " of the straw) is the operation which follows retting, and its object is to complete, mechanically, the process begun during retting, viz. the removal of the flax fibres from the woody parts of the stem. In Russia a great part of the fibre is cleaned by a wasteful method of hand scutching, but in Belgium and other parts of the Continent, and in Ireland, hand labour has been superseded by power machines which may be owned by the farmers either individually or on a co-operative basis, or, more commonly, by companies working scutching mills which purchase the retted straw from the farmers in the district. The straw, when brought into the mill, is first " levelled," with the object of straightening and opening out the straw and causing the butt (root) ends of the individual stems to settle down on the same level. This process is carried out by means of a simple " butting machine," which consists essentially of a vibrating vertical frame holding the straw, the butts of which are shaken down on to a table which also has a vibratory motion.

The levelled straw is then passed to the breaking

machines, where it is fed between a series of fluted metal rollers arranged in pairs in order to break up the woody core (shieve or shive) of the stems and to remove as much of the wood as possible without injuring the fibre. Usually the rollers are so adjusted that each pair works more closely together than the preceding pair.

The straw is then ready for the scutching machine. Various forms of scutchers have been used in different countries, but in most cases the mechanical principle is the same. In a common type, a substantial vertical wooden board, known as the " stock," is cut near the top to form a wide horizontal slot, open along one edge of the board. Close to, and in front of, the opening the flat wooden beaters of the scutching wheel pass in a plane parallel to the stock. The Irish type of scutching wheel, with six or eight heavy blades, revolves at a high speed and is well adapted to the strong Irish flax; but the Belgian wheel, fitted with twelve or more light blades and revolving at a much lower speed, causes less damage to the fibre. The flax from the breaking machine is held by hand over the lower edge of the slot in the stock and scutched by the beaters as they rotate. The effect of this process when completed is to remove the shieve and to leave in the hands of the operator a " strick " of cleaned flax free from shieve and with the strands of fibre more or less completely separated. The cleaned fibre is straightened by combing and then twisted into hanks or " heads," which are tied in bundles. During the scutching process the shorter and weaker fibres are pulled out of the strick by the scutching blades and fall behind the machine. This material, when re-scutched, is known as " tow," and has a much lower market value than the finished flax.

Bad scutching, resulting either from the employment of unskilful work-people or from the use of unsuitable machines, seriously lowers the market value of the flax and in addition increases the proportion of tow to flax.

Flax-pulling Machines

A flax-pulling machine, to be successful, must conform to all the conditions laid down for ordinary hand

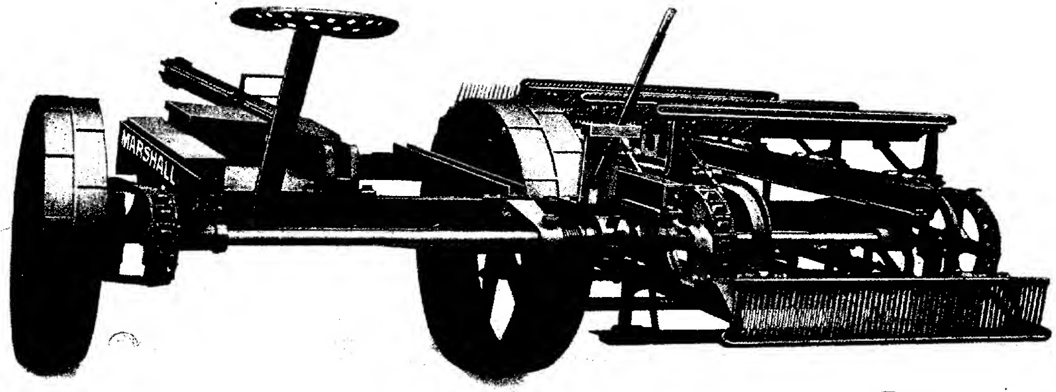
pulling, while the amount of flax pulled must be sufficient to render the use of the machine cheaper than hand labour.

A flax-pulling machine patented by the Fibre Corporation, Ltd., and manufactured for the Corporation by Messrs. Marshall, Sons & Co., Ltd., of Gainsborough, has attracted considerable attention (Plate V). The pulling mechanisim consists essentially of a steel framework carrying a number of mild steel combs fitted on two endless chains, and is mounted laterally on a two-wheeled travelling carriage on which the operator is seated in control of the lever for throwing the combs in or out of gear. The inner wheel of the carriage transmits motion to the pulling mechanism by means of a clutch and chain drive. The machine is built for attachment to a motor or tractor, but, if desired, it may be drawn by horses. As the machine travels forward, the combs move backward on the underside, this action, it is claimed, reducing to a minimum the possibility of de-seeding the flax in an over-ripe crop.

The engaged flax is drawn beneath the pulling mechanism at a slow speed, which amounts to the difference between the rate of advance of the whole machine and the rate of backward travel of the combs. This ingenious arrangement is of considerable advantage, since it enables the machine to travel at a greater speed than the revolving combs. The pulled flax is carried in the combs to the rear of the machine, where it is delivered to the ground at regular intervals by the action of comb cleaners operated by a stationary cam on the underside of the puller. The machine takes a 36-in. swathe, and is capable of dealing with from five to ten acres per day according to the character of the land and crop and the kind of traction employed.

The puller is adjustable in height and as regards its angle to the ground, so that varying lengths of crop may be dealt with satisfactorily. Practically all weeds are left standing in the field. This machine has given satisfactory results in public trials carried out by the Irish Department of Agriculture and Technical Instruction, and also in tests conducted in France.

PLATE V



Flax-Pulling Machine (Fibre Corporation Patent). Manufactured by Messrs. Marshall, Sons & Co., Ltd.

De-seeding Machines

De-seeding, while less important than either pulling or scutching, is nevertheless an operation in which machines could be more economically employed than the hand methods used hitherto.

The chief considerations in the design of de-seeding machines are that they shall strip off all the seed bolls effectively, leaving none attached to the stem and branches, and do so without injury to the seed itself. The straw must also be delivered straight, and free from tangles, since tangled straw in the retting tank results in an undue proportion of tow. Further, the stems must not be bruised or broken, or the retting will be unequal.

A power machine patented by the Fibre Corporation, Ltd., and made by Messrs. Marshall, Sons & Co., Ltd., is stated to give satisfactory results. This model is fitted with conveyors for carrying the straw across the machine for treatment by the metal combs which pull off the bolls. The combs keep the stalks separate, and the flax, when released from the gripping belts, is received even and straight. The power required for this machine is 7 B.H.P., and the out-turn is about 8 tons of straw per day of ten hours.

Boll Crushing Machines

These machines are employed for cracking the bolls and separating the seed from the hulls after de-seeding. The principal requirements in such machines are that they shall perform the separation effectively, and at the same time cause no damage to the seed. Damaged seed naturally results in low germinating power, a matter of great importance if the seed is to be used for sowing.

The boll crusher made for the Fibre Corporation, Ltd., by Messrs. Marshall, Sons & Co., Ltd., consists of a single fluted roller working against a fixed concave breast-plate, the bolls being fed between these two components, the space between which is adjustable. The bolls are cracked and the seed falls through without damage. The machine requires a power of 4 B.H.P., and is capable of dealing with 6 tons of bolls per day of ten hours.

It is understood that a new boll crushing machine is being designed by Messrs. Robert Boby, Ltd., of Bury St. Edmunds, patentees and makers of flax de-seeding appliances and machinery for cleaning and handling linseed. This machine is planned to combine the action of the usual de-seeder and boll crusher, and also the cleaning of the resulting linseed. It will effect the stripping and crushing of the bolls in one operation, thus materially reducing the labour, costs, and waste incidental to the general practice of installing and operating separate machines, with the intermediate transportation of the material between the units.

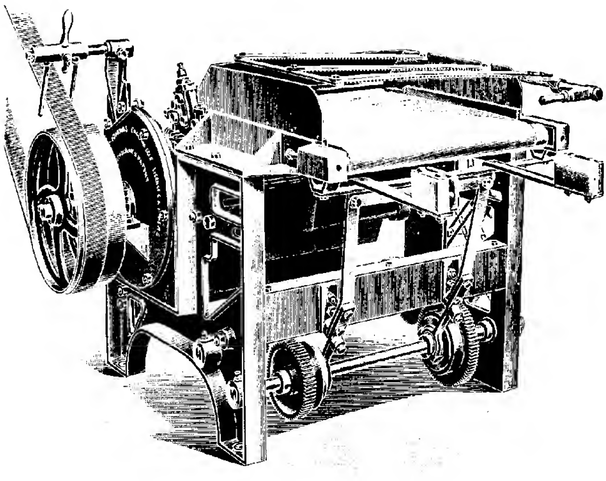
Scutching Machines (including combined Breaking and Scutching Machines)

For a long time efforts have been made to perfect a scutching machine requiring no more than easily acquired skill on the part of the operator and, at the same time, adjustable to varying qualities of straw and producing the minimum of tow. The invention of a satisfactory single machine capable of carrying out both the scutching and also the previous breaking processes is obviously desirable. The remarkable increase in attention given to the production and preparation of flax during the war and subsequently, as well as the high cost of labour, has provided a strong stimulus to the inventor, and more than one type of improved flax scutching machine has been placed on the market.

One of the most recent of these machines is the "Boby" automatic combined flax breaking and scutching machine (Swynghedauw's patent) manufactured by Messrs. Robert Boby, Ltd., of Bury St. Edmunds (Plate VI). The "Boby" machine presents two outstanding features. In the first place the use of a separate "flax breaker" is dispensed with, the machine being fitted with breaking rolls, in addition to the scutching drums, thus effecting a great saving of labour and power; secondly, the scutching action is on a principle entirely different from that of the ordinary flax scutching wheel.

The Boby machine occupies a floor space of about 6 ft. by 4 ft. The horse-power required is low, viz. 1¼ H.P.

PLATE VI



The "Boby" Automatic Combined Flax-Breaking and Scutching Machine (Swynghedauw's Patent). Manufactured by Messrs. Robert Boby, Ltd.

per machine. A machine can be worked by two boys or girls; two machines placed side by side can be operated by three persons.

An endless and reversible conveyor band, occupying nearly the whole width of the machine, forms the table from which the flax straw is fed between the breaking rolls. The latter are arranged immediately in front of the scutching apparatus and serve to hold the straw in tension while it is being scutched.

The scutching mechanism consists of a revolving frame fitted with two or more scutching cylinders each carrying a number of longitudinal steel blades parallel with the axis of the cylinder. These cylinders are operated by a sun-and-planet gear which causes them to revolve at a considerable speed, and at the same time they are carried round by the revolving frame in which they are mounted. At one side of the set of revolving cylinders, and concentric with their circular path, is a fixed grid, concave in form and provided with longitudinal blades similar to those of the cylinders and arranged parallel with them. As the revolving cylinders pass over the grid, both sets of longitudinal blades work in mesh, and it is by the introduction of the flax straw between the fixed and revolving blades that the shieve (wood) of the straw is removed from the fibre and falls below the machine, whence it may be removed by bagging on the spot or carried away by a special conveyor; alternatively, the machine may be fitted with an exhaust fan, or a single large fan can be arranged to suck the débris from a number of machines working together.

All the bearings of the machine are ball-bearings, in a special dust-proof housing which requires no oiling, since the housings are grease-packed.

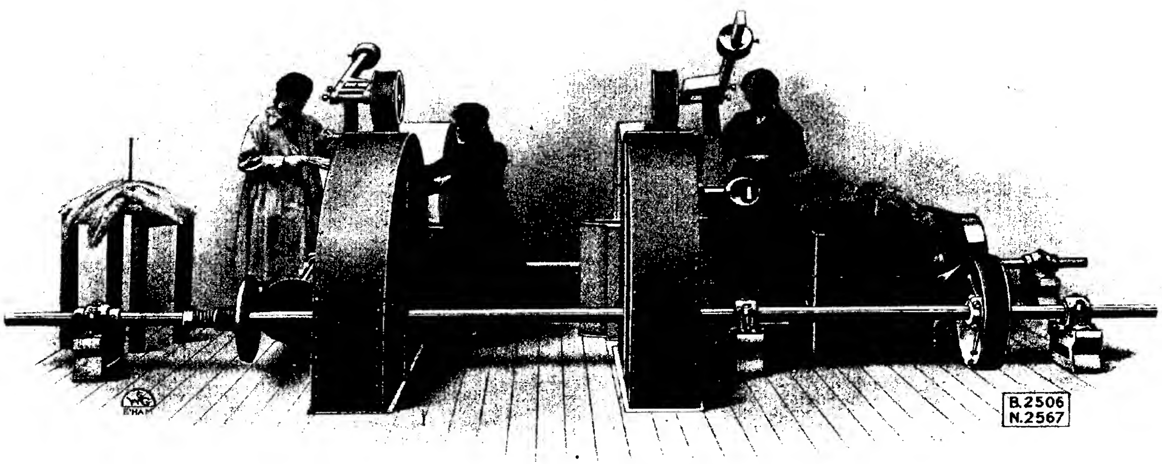
All classes of flax may be scutched by the machine, which can be regulated to vary the amount of scutching considered necessary by the operator, who stands in front of the conveyor band. In working the machine the flax straw is rapidly spread out by hand on the conveyor band, which, in travelling forward, presents the straw to the breaking rolls between which it passes for the removal of the shieve. The straw leaves the breaking

rolls and is at once engaged between the fixed and revolving blades of the scutching mechanism until about three-quarters of the entire length of the straw has been cleaned. The conveyor band is then reversed and the straw quickly withdrawn and reversed in position on the conveyor, which is at once started in the forward direction so that the untreated end of the straw is passed between the breaking rolls and scutching cylinders. Thence it is withdrawn in the form of cleaned fibre. The reversal and recovery of the conveyor band is effected by means of a simple clutch gear, which is controlled by two long iron levers, which project backwards one on either side of the body of the workman who operates the lever by a simple lateral movement. The scutched fibre, as it leaves the machine, appears in undivided tape-like strands of full length, each of which represents the fibre content of a single flax stem free from damage.

The advantages claimed for the machine are as follows: (*a*) A much larger yield of cleaned fibre from the straw than hitherto obtainable by other machines; (*b*) a much smaller quantity of tow; (*c*) a combination of breaking rollers and scutcher in one machine; (*d*) production of long fibre, free from short ends; (*e*) ease, simplicity and safety in working; (*f*) low horse-power per machine. Excellent reports on the "Boby" machine have been received from flax-growers in this country, as well as from growers in North Africa and Canada. In the country last mentioned trials with the machine have been conducted under Government auspices, with very satisfactory results. The machine was also recently exhibited at the Sorau Exhibition (Germany), and received most favourable reports from flax experts.

Another automatic scutcher is the Speedo Flax Scutching Machine patented by the Fibre Corporation, Ltd., and manufactured by Messrs. Marshall, Sons & Co., Ltd. (Plate VII). This machine differs widely from that previously described. It deals solely with the scutching of the fibre, the previous breaking of the straw being carried out by a separate crimping or breaking machine, of which the firm manufacture an improved type, which does not stretch or damage the flax in any way. The

PLATE VII



The "Speedo" Automatic Flax-Scutching Machine (Fibre Corporation Patent). Manufactured by Messrs. Marshall, Sons & Co., Ltd.

underlying principle of the scutcher is a very effective use of pairs of flax-scutching wheels of ordinary type mounted for power driving, and capable of flexible control as regards speed of revolution and adjustment with relation to the stocks. It is claimed that this machine furnishes a most efficient imitation of ordinary hand-scutching, and at the same time each successive phase in the process is completed automatically.

The machine is of simple design. Pairs of revolving flax-scutching wheels (each built of the usual rings and blades and fitted with detachable casings which also act as safety-guards) are provided, each pair consisting, as in ordinary scutching practice, of a "boffer" and a "finisher," the latter being more closely set against the stock. Each strick of flax is dealt with by the boffer and finisher successively. A machine comprises two such sets of scutching wheels, one set dealing with the root end of the flax straw, while the other treats the top end. The straw is held by gripping belts, which run round three pairs of guide pulleys. The lower pair of these are fitted with teeth and serve to hold up the flax under the blows of the scutching blades. The pulleys to which the teeth are attached, and also the stock, are adjustable as regards distance from the scutching blades. The feed is vertical, a boy or girl introducing, one at a time, the stricks of straw (previously passed through a breaker) between the two gripping belts, which pass round the guide pulleys and convey the flax first to the boffing wheel and then to the finishing wheel.

The strick is firmly held by the belts until the root end has been boffed and finished. The strick is then removed by the attendant, who places the scutched end into the second half of the machine between the gripping belts serving the pair of scutching wheels dealing with the top end of the strick. After this operation is completed the strick issues fully scutched, the process involving a thorough cleaning of the heart of the strick.

Special attention has been given to the provision of adjustments for dealing with the straw in varying condition as regards retting, without stopping the machine for the purpose of resetting the adjustable parts. If the

straw is very " hard," as a result of insufficient retting, close scutching is called for; on the other hand, " soft " or over-retted fibre requires more moderate treatment. The varying treatment necessary is provided by the use of a disc friction drive, which can be regulated to give any required speed while the machine is actually running. The setting of the stock can also be effected without interfering with the running of the machine. Both of these adjustments can be made to the whole or part of a machine independently of other machines and while the speed of the main driving shaft remains constant.

Attention is called to the advantages resulting from the fact that the machine is designed for installation on an upper floor or over a basement, with a view to the effective treatment of the accumulated tow and shieve which, in ordinary practice, is frequently separated by shaking in the scutching room, to the detriment of the workpeople, owing to the resulting clouds of dust. In the case of the Speedo machine this work is carried out in a separate, lower compartment completely shut off from the scutching room above. The shieve and tow drop by gravity through special openings in the floor, the coarse tow falling from the boffing side of the machine and the fine tow from the finishing side, in two separate heaps. The lower apartment should be made as air-tight as feasible and provided with a suction fan, fitted in the wall, for the extraction of dust from within the machine casings through the floor openings beneath the machine. Each machine is capable of dealing with 12 tons of broken straw per week of fifty-five hours. Unskilled labour only is required, and three men, boys or girls are needed for each machine. As regards horse-power, if three machines or less are employed, the power required is 8 B.H.P per machine; for any number of machines in excess of three, if in one installation, 5 B.H.P. per machine is sufficient.

NOTES

Germination of Indian Barley.—In 1913 the Imperial Institute called attention to the fact that early shipments of Indian barley germinated well, while the later shipments were liable to contain a large percentage of grains that would not germinate, sometimes amounting to 10 or even 20 per cent. As this defect lowered the value of the barley for malting purposes the matter was referred to the Department of Agriculture, United Provinces, with the suggestion that the poor germination was due to exposure. According to experts consulted by the Imperial Institute, it seemed possible that the barley which suffered injury was that which failed to get railed and shipped before the monsoon set in and was consequently stored in cultivators' pits and huts, and that the damage was caused by the humidity and warmth of the rainy season, followed by the drying of the barley before it reached England.

Experiments on the influence of atmospheric conditions on the germination of Indian barley have now been carried out by Mr. W. Youngman, B.Sc., Economic Botanist to Government, United Provinces, and the results are published in *Mem. Dept. Agric. India, Botanical Series* (1921, **11**, No. 6, 145). In these experiments, barley was exposed to air of various degrees of humidity for different periods, and the effect on its germinating power was determined in each case. The results showed that exposure to an atmosphere having a water vapour-pressure of 1·3 inches at a temperature of 31° C. for a period of twelve weeks reduced the germinative capacity of the barley to zero, while humidity of 0·87 inch vapour-pressure at 30·5° C. had no effect whatever on the germinating power. Between these extremes intermediate degrees of humidity correspondingly influenced the germinative capacity, and a vapour-pressure of 0·87 inch at 30·5° C. may therefore be taken as the maximum humidity to which barley intended for malting may be safely exposed. Having determined this factor, the mean daily aqueous vapour-pressures for the various districts of India at different times of the year were considered. A series of maps giving this information for each month of the year is to be found in the "Climatological Atlas of India," from which it is seen that from October to April vapour-pressures above 0·85 inch are rarely encountered anywhere in India, even on the seaboard. On the other hand, during the period of the monsoon, i.e. after May, barley in North-Eastern India would be subjected to atmospheric conditions which

would have a deleterious effect on its germination, the vapour-pressure being as much as 0·95 inch. Barley required for malting purposes should therefore not be exported from Calcutta after May. The barley usually exported from Calcutta is produced in Bengal, Bihar and Orissa, and Oudh. Its germinating power could be fully protected by transporting it from the danger zone towards Karachi or Bombay before the end of June. Barley in North-West and Central India would not meet with adverse conditions at any time of the year, but in the seaboard area from Karachi to Bombay the vapour-pressure after May rises to 0·90 inch. Barley exported at that period through these ports would not, however, suffer appreciably if it were not delayed long in the seaboard area. Although the humidity conditions over the ocean which the grain encounters on a normal voyage to Europe may be above the safety maximum, they are not likely to last long enough to produce any serious effect.

Pink Cotton Boll-worm.—An account of the pink boll-worm with special reference to the damage which it has caused to the cotton crop of Egypt has been given in this BULLETIN (1918, **16**, 362), and particulars regarding its occurrence in the United States have also been recorded (1918, **16**, 263; 1919, **17**, 297; 1921, **19**, 80).

An interesting summary of the present situation in the United States with respect to this pest has been published in *Service and Regulatory Announcements* (*Fed. Hort. Bd.*, 70), *U.S. Dept. Agric.*, issued September 23, 1921, and contains the following information.

The pink boll-worm (*Pectinophora gossypiella*=*Gelechia gossypiella*) is a native of India and was conveyed from that country to Egypt in 1906–7 in shipments of unginned cotton. Since that time it has been introduced into most other cotton-growing countries through the agency of Egyptian cotton seed. About the year 1911 it was carried into the Laguna, the most important cotton district of Mexico, in Egyptian cotton seed imported by Mexican planters. From Mexico it entered Texas in 1915 or 1916, and as soon as it was discovered, safeguards were provided against the further entry of seed and cotton from Mexico, and the earlier importations were traced in order to locate the points of possible infestation in Texas. These points proved to be very few and there seemed to be a reasonable hope of exterminating the pest in that State. Unfortunately, however, that hope was not fulfilled, although large appropriations were made by Congress for the prevention of the further entry of the insect and for the work of eradication.

It is now fully recognised that the pink boll-worm is a serious menace to the cotton crop of the United States. Consideration of the losses caused by this pest in recent years in Egypt, Brazil, Hawaii and Mexico has indicated that its establishment throughout the cotton belt of the United States would result in an annual loss of 20–40 per cent. of the crop, equivalent to several hundred million dollars. In this connection it is pointed out that the loss in the Laguna region of Mexico has been gradually increasing and in 1920 amounted to about 50 per cent. of the crop.

In Texas, five areas have been infested by the pink boll-worm, viz. the Hearne, Trinity Bay, Pecos Valley, Great Bend and El Paso districts. Of these areas, the Hearne, Great Bend and Pecos Valley districts have now been nearly or completely freed from the pest; the infestation has been greatly reduced in the Trinity Bay district, and it is considered that in the El Paso area the insect could be exterminated by the maintenance of a non-cotton zone. The whole of the districts infested represent less than 1 per cent. of the total cotton area of the State, and the prospect of completely eradicating the pest is sufficiently promising to justify every effort to accomplish it. It is necessary, however, that the State of Texas should give adequate legal support and co-operation. The failure of Texas to provide the quarantine and control work considered necessary by the Department of Agriculture to keep the pest within its present limits in the State and the abandonment of the policy of compulsory non-cotton zones, necessitate careful consideration of the whole work of pink boll-worm control in the United States in order to prevent the insect spreading throughout the cotton belt.

In Louisiana the presence of the pink boll-worm was discovered in the winter of 1919–20 in three parishes adjoining the Trinity Bay district of Texas. Prompt action was taken and the three parishes were maintained as non-cotton zones in 1920. The prospect of the extermination of the pest in this State is very promising. The insect has since appeared at only one new point, viz. Shreveport, and here a non-cotton zone was provided for 1921 with a wide surrounding regulated or safety zone.

In New Mexico there is a slight infestation north of El Paso and another at Carlsbad in the Pecos Valley. Suitable action has been taken and this State can now be included in any quarantine or control operations undertaken with respect to any or all of the invaded States.

The efforts made by the Department of Agriculture, in conjunction with the States concerned, to eradicate the

insect would, if successful, eliminate the danger from the pest indefinitely. This involves the prohibition of the cultivation of cotton in infested areas and the provision of adequate control in surrounding and other safety zones. The action of Texas in failing to adopt fully the recommendations of the Department of Agriculture is liable to have a serious effect on other States, including Louisiana, where the effort to eradicate the insect is proceeding with full State support and with every promise of success.

In the opinion of the experts of the Department of Agriculture, the extermination of the pink boll-worm is quite possible provided that adequate support is given to their endeavours by the States concerned. The opportunity must, however, be seized at once, and the necessary control measures carried on efficiently and without intermission for at least three years, or otherwise the money spent will be wasted and the opportunity for exterminating the pest will be lost altogether.

Mineral Resources of Syria.—An account of the mineral resources of Syria by I. M. Toll, of the U.S. Geological Survey, appeared in *Eng. and Min. Journ.* (November 26, 1921, p. 846). The deposits at present known are of very little importance, but a great deal of country remains to be prospected, especially in the province of Aleppo, which gives the greatest promise. The Turkish attempts to develop the country's resources were very desultory and incomplete. A brief account of the structure of the country is given and details of the Turkish mining law of 1906 with the recent French amendments.

The known mineral deposits are chiefly non-metallic. Coal and lignite occur throughout the country, but are of poor quality; the latter is worked chiefly near Karnail (1,000 tons per annum), at Haitoura, near Jezzin (500 tons per annum) and at Aebdin, near Bekfaya. Numerous small deposits are known.

Petroleum and asphalt occur chiefly around Alexandretta, Latakia, Beirut and in the upper valley of the Jordan River, and bituminous limestones occur near Damascus and at the springs of the Jordan. An account is given of the various attempts which have been made to exploit these oil regions, all of which have hitherto failed. The asphalt and bituminous limestones have alone been profitably exploited. The great asphalt deposits near Latakia, estimated to contain over 2,000,000 tons, produced 79 tons in 1906, but owing chiefly to difficulties of transport the project was ultimately dropped. Beirut asphalt has also been exported, but the chief asphalt

mines are at Hasbaya, near the source of the Jordan. These have been worked since the time of the Egyptian occupation, and from 1890 to 1900 produced 66,000 tons. This asphalt is of great purity, containing over 70 per cent. of bitumen and volatile constituents. During the war the authorities of the Hedjaz railway attempted to distil some of the abundant bituminous limestone in order to obtain oil for lubrication, of which there was a great scarcity. The limestone of Makarin in the Yarmuk Valley, which contains about 20 per cent. of bituminous material, was used for the experiment, and the yield was 45 kg. per ton.

Salt is abundant but comparatively undeveloped. The Turkish works at Jebbul, 35 kilometres south-east of Aleppo, produce less than 10,000 tons per year, whereas they might produce ten times as much. Here the salt is obtained from a lake 35 kilometres long and 20 kilometres wide, which becomes entirely desiccated in summer, yielding a deposit of pale rose-coloured salt up to 5 millimetres thick. Farther to the south are numerous other small salt lakes which have not been exploited. Salt of high quality is found at Tadmor, a small lake in the Syrian desert; at Ain-el-Gom, also in the desert; and a small quantity is produced annually from the bitter salt obtained from the marshes of Jerud, north-east of Damascus.

Springs possessing therapeutic value are numerous, particularly in Aleppo Province. Those of Hammi, near Damascus, are large and noted. They were used by the Romans and to-day are visited by Arabs even from Persia.

Fine marble is quarried in numerous localities, and there is also much gypsum (alabaster). Important deposits of red and yellow ochre are worked in Beirut Province, and rocks with a small percentage of phosphate are widespread but are chiefly worked in the Barada Valley. There is an unworked deposit of pandermite (= priceite, a source of borax), near Antioch.

Iron ores are abundant and are worked at numerous localities. Those of Lebanon have been used since Phœnician times, the best known being in Wadi Sannin in Jurassic limestone. This deposit is in lenses parallel to the strike, which is N.W.–S.E. and consists of hæmatite, limonite and siderite. The methods of mining employed are very primitive, but a high-grade product is produced. Many deposits are undeveloped on account of lack of transport and communications.

The chromium-bearing area of Asia Minor extends to Syria and deposits are known in Aleppo, in the Ala Dah, the Beilan area and the Amanus region north-east of

Alexandretta. Also at Catana, near Damascus, and in Beirut are deposits yielding 40 to 50 per cent. of chromium. The latter have been worked on a fairly considerable scale.

Copper is known in every vilayet, but has not so far been developed. Lead ores are known in the Amanus "massif" and silver-lead ores at Jebel Akra, where nickel also occurs. Silver occurs near Homs; in the Kesserwan district of Lebanon; and is mined at Tonfail. Gold-bearing sands occur in stream beds near Antakia. Licences for the mining of tin, copper and silver were applied for by an Australian company, in the Kesserwan district, but work was discontinued on the outbreak of war.

The article is illustrated by a map showing the mineral deposits at present known and a useful bibliography of the literature of Syrian geology is appended.

Iron-Ore Deposits of Latin America.—In *Eng. and Min. Journ.* (September 17, 1921) an article by D. E. A. Charlton (quoted from *Ingeniera Internacional* of October 1921) gives a general idea of the distribution of the known iron deposits of Latin America, which is summarised below:

Mexico.—It has been estimated that the total reserve of iron ore in Mexico amounts to 242,978,000 tons, the principal deposits being in Lower California, Coahuila, Durango, Guerrero, Michoacan and Oaxaca. The largest and best known iron-ore deposit, the Cerro del Mercado, near Durango City, is said to contain about 200 million tons of magnetic iron ore containing 63 per cent. of iron.

In Lower California the iron-ore deposits near San Isidro are extensive and much ore has been uncovered, although little actual mining has been done. Small iron-mining operations are being conducted in Hidalgo, Puebla, Vera Cruz and Oaxaca, and work has been started on the mines of Las Truchoas, Michoacan.

Cuba.—According to T. E. Spurr, there are two principal groups of iron-ore deposits in Cuba: magnetite and hæmatite ore on the south coast, and brown ore or limonite on the north coast, all near the eastern end of the island.

The ores of Firmeza and Daiquiri on the south coast are mixed magnetite and hæmatite, containing, on the average, about 58 per cent. of iron and 0·03 per cent. of phosphorus. The ore reserves have been variously estimated at 5 to 9 million tons. The brown hydrated hæmatite of the north shore contains about 40 per cent. of iron, 0·01 of phosphorus and 1·7 of chromium. The ore reserves, estimated at

3,000 million tons, are mainly contained in the three large deposits of Camaguay, Mayari and Moa.

Brazil.—Iron ore exists in practically every state of Brazil, and the deposits are said to constitute the greatest and richest undeveloped iron-ore reserves in the world. The most important are those of the State of Minas Geraes, which lie in an area roughly 100 miles square, the centre of which is about 220 miles north of Rio de Janeiro. These principally occur in an iron-bearing quartzite called "itabirite." The ores are chiefly hæmatite and limonite, and contain from 55 to 65 per cent. of iron and moderate amounts of phosphorus. It has been estimated that the Minas Geraes iron ores amount to 3,500 million tons. Other important iron-ore deposits exist in Parana, Bahia, São Paulo, Santa Catharina, Espirito Santo, Matto Grosso, Goyaz and Rio Grande do Sul.

Chile.—The iron-ore deposits of Chile occur in the coastal mountain region, the principal deposits extending for a distance of about 150 miles parallel to the coast. The best known and most developed are the Tofo deposits. The Tofo iron mines are in the province of Coquimbo, about 5½ miles from the port of Cruz Grande. The iron-ore reserves are estimated at 200 million tons, containing, on the average, about 68 per cent. of iron and 0·05 per cent. of phosphorus. Mining at Tofo is by open cut methods and little overburden is encountered.

Peru.—Iron-ore deposits of considerable importance are found in Peru, and not only are they of good grade, but their proximity to coal and limestone adds to their commercial value. At Aija, Department of Ancachs, are deposits of magnetite, and north of Aija are similar iron deposits at Callycancha in the same department. The iron content ranges from 51 to 70 per cent. of iron. One of the chief iron-ore deposits of Peru is at Huancavelica in the Province of Huancayo near Mantaro River. The ore is hæmatite with small amounts of pyrite; limestone is abundant and the coal-fields of Jatunhuasi in the immediate neighbourhood make the exploitation of the deposits practical. Water power is available from the Virgin and Mantaro Rivers.

The deposits of iron ore at Marcona, Province of Ica, have been estimated at 500 million tons. The ore is a good grade of hæmatite with low percentages of phosphorus and sulphur. The short distance to the sea renders transportation of the ore an easy matter. The exploitation of the coal-fields at Huayday will doubtless influence the development of the Marcona iron-field.

Other Countries.—Deposits of iron ore occur in several

other countries of Latin America, those of Colombia, Venezuela and the Guianas being of some importance, on account of their proximity to the coast.

In Colombia deposits of considerable extent occur in the department of Cundinamarca. Others are known, but are at present too inaccessible.

In the delta region of the Orinoco River, Venezuela, are lenticular hæmatite ore deposits containing, on the average, 65 per cent. of iron.

Micaceous iron schists and other types of iron ores are found in various parts of Uruguay, north of the City of Minas. Large pockets of good grade hæmatite are found in the Department of Cerro Largo.

In Paraguay are iron deposits which are not of great extent and which may become available when transport facilities are increased.

The so-called "Iron Mountain" of Agalteca, 48 miles north-west of Tegucigalpa, Honduras, is estimated to contain several million tons of high-grade magnetic ore.

In Porto Rico, iron-ore deposits are scattered and their development is mainly dependent on better transport facilities. The districts of Guayama and Huanacao are rich in iron ore and indications of deposits extend for nearly 10 miles from the eastern end of the island towards Juncos. The ores are chiefly hæmatite and magnetite, assaying about 60 per cent. of iron with low percentages of phosphorus and sulphur.

There are further deposits on the south side of the island, but here also development awaits transport facilities.

RECENT PROGRESS IN AGRICULTURE AND THE DEVELOPMENT OF NATURAL RESOURCES

In this section of the Bulletin *a summary is given of the contents of the more important papers and reports received during the preceding quarter, in so far as these relate to tropical agriculture and the utilisation of the natural resources of the Colonies, India and the Tropics generally. It must be understood that the Imperial Institute accepts no responsibility for the opinions expressed in the papers and reports summarised.*

AGRICULTURE

Foodstuffs

Yerba-maté in Paraguay.—The gathering and preparation of yerba-maté or Paraguay tea constitute one of the most important industries of Paraguay. According to the *Report on the Economic and Financial Conditions in*

Paraguay, Sept. 1921 (pp. 6–7), published by the Department of Overseas Trade, the tree grows wild over an area of 15,000 to 20,000 square miles in the forests of the north-east of the country. The industry is in the hands of three or four large companies, the most important, which is under British control, owning some 10,000 square miles of territory; but a certain amount of surreptitious exploitation of the forests also takes place, and is difficult to prevent on account of the vastness of the areas covered. The registered production of yerba-maté averages about 10,000 tons annually, and the selling price of the finished product is between £50 and £60 per ton. There is a large demand for it from Argentina, and markets for it also exist in Europe and the United States (cf. also this BULLETIN, 1920, **18**, 494).

The systematic cultivation of the crop in plantations has been started, mainly by Germans, and it is estimated that some 2,000,000 trees from two to four years old, grown from seed, have been set out. Full-grown trees produce from 30 to 40 kilograms of leaf each season, and it is anticipated that in 6 to 8 years the trees in the new plantations will already be yielding some 6 kilograms annually. This greatly increased production appears to be justified by the demand. The raising of the trees in plantations has the great advantage that the working can be carried out under adequate supervision, instead of by men sent into the forests where they are out of sight and frequently cause reckless destruction of the trees. The collection of the leaves can also be more easily effected in plantations, where carts or lorries can be run between the rows of trees. The provision of adequate transport facilities is important, and there are proposals to construct cheap railways to the districts where they are most needed.

Much information relating to yerba-maté will be found in a series of publications of the Museo Agricola, Buenos Aires, issued at intervals since 1918. The first three parts deal with substitutes and adulterants of maté, and later issues with the cultivation of the crop.

Leaf-rolling Insect Pests of Tea in the Dutch East Indies.—It is a noteworthy fact that certain insect pests of tea, which are common to several countries, show marked differences in their relative importance as destructive agents in different countries. Thus in the Dutch East Indies, *Laspeyresia theivora*, Meyr. ("poetjoekroller") and *Gracilaria theivora*, Wals. ("dwarsroller") are serious tea pests, particularly the former, whilst in India only the latter is of economic importance. On the other hand,

Homona coffearia, Nietn. (" tea tortrix "), which is the most destructive lepidopterous enemy of the tea plant in Ceylon, is not regarded as a serious pest in the Dutch East Indies.

These three insects form the subject of *Med. van het Inst. voor Plantenziekten*, No. 51, 1921, published by the Department van Landbouw, Nijverheid en Handel, Batavia. The suggestion is made that the difference in the incidence of the pests may be due to the existence of different parasites in the countries concerned, *Homona* being kept in check in Java by a parasite (or parasites) not occurring in Ceylon, whilst other parasites having *Gracilaria* and *Laspeyresia* for their hosts are present in Ceylon, but not in Java. Several parasites found in the Dutch East Indies have been studied, and are described and figured in the publication under consideration. British tea planters are invited to compare with them the parasites found preying upon the tea pests in question in India and Ceylon, in order to test the truth or otherwise of this suggestion, and also possibly with a view to a mutually beneficial exchange of parasites.

The habits and life-histories of the three insects are described, with illustrations of their various stages of development and of the damage which they effect. An interesting discovery claimed by the author is that the male and female of *Homona coffearia* hitherto have been supposed to be different species, the female being named *H. menciana*, Wlk.

As remedial measures, three methods are already in use against *Laspeyresia* and *Gracilaria*, viz. (1) plucking the attacked leaves and collecting the caterpillars ; (2) removing the caterpillars from the leaves ; and (3) pinching the attacked leaves to destroy the caterpillars without removing the leaves. In the present publication the first of these three methods alone is discussed, and suggestions are made for systematising it. It is proposed that at each plucking, in addition to taking shoots which are normally ready for plucking, all visibly attacked shoots should also be plucked. One such plucking would not eliminate the pest, since eggs may be present on shoots too young to be plucked, pupæ may escape detection, and there may be moths still on the wing and shortly about to deposit their eggs ; but after the process has been repeated a certain number of times at short intervals the garden should be entirely free from the pest. The rationale of the method is made clear by diagrammatic " time-schemes" in which the life-histories of the insects are correlated with the successive times of plucking. Tea-plants affected by

Laspeyresia, plucked in this manner at twelve-day intervals, would, at the altitude of Tjibodas (1,400 metres), require about six or seven rounds of plucking to free them from the pest, while in the case of *Gracilaria* at the altitude of Buitenzorg (250 metres) some six to eight pluckings at eight-day intervals would be requisite.

The cultural objections to heavy plucking in young plantations are admitted, but it is regarded as probably the lesser of two evils, and it is suggested that practical trials should be made on the lines indicated.

The distances which the moths are capable of travelling have not been recorded, though these distances constitute an important factor determining the areas over which concerted measures must be taken simultaneously if they are to prove effective.

Oils and Oil Seeds

Carya tonkinensis.—The preparation of the oil from the seeds of the "May-Chau" tree (*Carya tonkinensis*, H. Lec.), is described in the *Bull. Econ. Indo-Chine* (1921, **24**, 624). The oil is only prepared in sufficient quantities to meet the requirements of the native population, seeds that have fallen from the trees alone being used. After the nuts have been shelled, the kernels are pounded up, warmed by steam to between 40° and 50° C., and then placed in a bamboo basket and pressed in a native wedge press. By this method the kernels yield about 6 per cent. of a thick, yellowish-green oil, which is chiefly used for lighting purposes and, when lard is scarce, as an edible oil. The residual cake is fed to pigs, which eat it readily.

Ground Nuts.—According to the final forecast for the season 1921–1922 (*Ind. Tr. Journ.*, 1922, **64**, 253) the total area under ground nuts in India is estimated at 1,946,000 acres, and the yield at 920,000 tons, decreases of 8 and 10 per cent. respectively compared with the figures for the previous year. Madras is by far the most important producer of ground nuts with 1,428,000 acres under this crop or 11 per cent. less than in 1920–21. Want of rain at sowing time and low prices are responsible for this reduced acreage. The crop is estimated to yield 644,000 tons of nuts in shell against 740,000 tons for the previous season. Burma has 295,000 acres under this crop, a decrease of 3 per cent., while the yield should reach 95,000 tons, or 20,000 tons below that for 1920–21. Good prices for the previous crop encouraged this cultivation, but poor rains retarded the sowings and reduced the yield. Practically the same area (223,000 acres) has been sown

in Bombay this year as last, and is estimated to produce 181,000 tons or an increase of 8 per cent.

In many provinces of the Dutch East Indies the ground-nut plants are damaged by slime-disease (bacterial wilt), and in some districts where this crop is largely grown it is estimated that 25 per cent. or more of the produce is lost every year through this cause (*Med. van het Inst. voor Plantenziekten*, 1922, No. 52). Plants severely attacked by the disease wither and dry up quickly, while in cases of mild attack often only a portion withers; the root system shows a number of dead and discoloured roots; some of the fruits remain small with the skin not infrequently brown-veined. Trials of artificially infecting ground-nut plants with cultures were successful. The following measures for controlling the disease are recommended: Ground nuts should be planted during the dry monsoon and one crop should not be quickly followed by another sowing of the same. Heavy clay soils should be avoided. Only seeds of absolutely healthy plants should be used. On grounds infected with slime-disease the seed should be sown closely. Affected plants must be dug up and burnt immediately.

An account of trials of mechanical cultivation of ground nuts in Senegal in which the ploughing and the sowing were performed with the assistance of tractors is published in *Bull. Mat. Grasses* (1921, Nos. 11 and 12, 188). The machines used gave satisfactory results.

Jatropha mahafalensis.—The seeds of *Jatropha mahafalensis*, Jum. (Betratra), which grows in Madagascar, have long been known to be poisonous. The toxicity of these seeds has now been studied (*Bull. de l'Ag. Gen. des Col.*, 1922, **15**, 190). It was found that when an infusion of the seeds was injected subcutaneously into a guinea-pig no ill effects were produced. Feeding trials showed that large doses of the meal were not eaten by animals. Small doses administered in mixture with ordinary food to a dog and a goat produced in eight to ten days slight diarrhœa, but the trouble disappeared on the resumption of the normal diet. Roasting the seeds destroys their toxicity (cf. this BULLETIN, 1920, **18**, 133).

Maize Oil.—A comparison of maize oils obtained by expression and benzole extraction is the subject of *Bull.* 1054 (1922), *U.S. Dept. Agric.* A comparison is made of the general characters and quality of three types of oil prepared

from (*a*) wet-process germs and (*b*) dry-process germs. The three types consisted of (1) expressed oils; (2) oils extracted by benzole from germs, and (3) oils extracted by benzole from cake from the presses. The six oils were neutralised, bleached and deodorised; their physical and chemical constants were determined, and their colour, odour and taste compared. It was found that the crude oils from the cake were the darkest; the benzole-extracted oil from the wet-process germs contained more free fatty acids than the corresponding oil from the dry-process germs; expressed oils lost the least on treatment with caustic soda, and the cake oils the most; no material difference was noticed between the finished oils from the germs immediately after preparation, but, on standing, some deterioration took place, especially of the extracted oils; all the oils from the germs, except that extracted from the wet-process germs, were sufficiently light in colour to make them suitable for salad and cooking purposes; and the oils extracted from the cakes were inferior in all respects to the other oils.

Oil-Palm.—With a view to the improvement of the exploitation and cultivation of the oil-palm in the Ivory Coast, it is suggested that an experiment station should be established in that country (*Bull. Mat. Grasses*, 1921, Nos. 9 and 10, 145). It is considered that the Plain of Dabou would be suitable for this purpose and that the cultivation of the oil-palm there should be successful. A plantation of 400 hectares is proposed as a start, which should yield sufficient fruits for a factory treating 25 tons per day. After seven or eight years an oil-mill might with advantage be installed, when the returns should cover the expenses.

An account of the work carried out since 1918 at the Agricultural Station at Bingerville is given in *Bull. Mat. Grasses* (1921, Nos. 9 and 10, 152). The programme included the management of natural palm forests, the selection of oil-palms and the cultivation of the selected palms. Two natural palm plantations were chosen, one to demonstrate the management to the natives and the other where crops were grown between the trees for the instruction of Europeans. The good effects of clearing the ground and of thinning and pruning the trees were demonstrated. Cocoa, coffee and kola are suggested for growing among the oil-palms. The preparation of a palm oil with a low free fatty acid content of 0·32–0·44 per cent. has been successfully performed. Experiments

have shown that the sterilisation of the fruits by steam is as satisfactory as heating in an autoclave. Selection trials have been made and a nursery started for growing the selected seeds.

Trials with the "Avance" motor tractor using palm oil as the fuel in the competition organised by the Belgian Ministry of Colonies (cf. this BULLETIN, 1921, **19**, 379) are described in the official *Rapport sur le Concours de Tracteurs à Huile de Palme*, 1920 and 1921. This implement, made by Svenson, of Stockholm, is a motor plough rather than a tractor. The engine is a vertical, semi-Diesel, two-stroke type of 14 horse-power, fitted with a gear-box and reverse, and is strongly made, the parts being readily accessible. In trials it worked as a plough as well with palm oil as with crude petroleum, but as a tractor it was found that although the engine was satisfactory, wheels with much wider rims would have to be fitted to render it suitable for traction on sandy roads (such as are found in the Congo). Trials with this tractor were also made in this country, near Shrewsbury.

Palm oil has been used successfully in Ruston motors of 15 and 42 horse-power. These are water-cooled four-stroke engines, which require no water injection, no preliminary heating of the cylinder, and no magneto (*Bull. Mat. Grasses*, 1921, Nos. 11 and 12, p. 201).

Sesame.—Although the area sown with sesame in India in 1921–22 was only 5 per cent. more than in 1920–21, yet the 4,641,000 acres under this crop (1921–22) are estimated to yield an increase of 35 per cent. of seed, the total yield being 515,000 tons (*Ind. Tr. Journ.*, 1922, **64**, 73; 1922, **65**, 99). The United Provinces, with an acreage of 1,225,000 acres and an estimated yield of 128,000 tons, grows more sesame seed than any of the other provinces. Madras, the Central Provinces and Berar, Bombay, and Hyderabad are the next in importance, with 786,000, 744,000, 611,000 and 554,000 acres respectively.

The Vegetable Oil Industry in the Bombay Presidency.—*Bulletin No. 3, Dept. of Industries, Bombay Presidency*, is devoted to a study, by A. F. Yuill, of the vegetable oil industry in the Bombay Presidency and the possibilities of its development. A survey is given of the existing oil-pressing equipment, which is considered sufficient to supply all the present requirements of the Province. The oil seeds which are available in commercial quantities are described, and the prospect of their development is

discussed together with the possibilities of their finding profitable outlets in India and elsewhere. The chief oil seeds grown are linseed, cotton seed, rape, sesame, castor seed and ground nuts, while among those of minor importance are poppy, niger, safflower and mowrah seeds and coconuts (cf. this BULLETIN, 1917, **15**, 353). The various types of machinery employed in modern oil-mills are described and a comparison of their efficiency, output, capital and working costs is made and their suitability for use in India considered. In the discussion of possible new uses in India for the products of the expanded industry, it is pointed out that the demand for edible oils in place of ghee is increasing, that locally made linseed oil is rapidly replacing the imported article, and that the use of castor oil as a lubricant is of growing importance. If the export trade in oils is to be developed, methods of marketing must be improved, especially as regards the type of containers, and standards of quality must be established. Particulars of a proposed standardisation scheme are given.

RUBBER

Hevea

Latex Yields.—The feasibility of determining the future yielding capacity of mature trees from a study of the number of rings of latex vessels in seedlings is discussed in *Arch. voor de Rubbercultuur* (1921, **5**, 574). The thickness of the bark (exclusive of cork) taken from 126 trees, 2½ years old, was determined, the number of rows of latex vessels was counted and the distance of each row from the cambium measured. It was found that no significant correlation occurred between the number of vessels in the outer half of the bark formed during the earlier period of growth, and that in the inner half of the bark formed later. Hence it seems unlikely that the number of rows of latex vessels in seedlings is proportional to the number in the mature trees. Samples of bark were also taken from a large number of mature trees (8 years old) and the number of rings of latex vessels in each millimetre counted from the cambium to the outer surface of the bark. The correlation figure for the number of latex vessel rings produced each year was very low. As a result of these experiments it is concluded that seedling selection based on the number of rows of latex vessels is impracticable.

An examination of nearly 1,000 8-year-old trees, the latex yield of which was accurately known for more than a year, revealed the existence of a high coefficient of

correlation between the yield of a tree and the number of rings of latex vessels in its bark ; but the correlation was not high enough to allow the number of latex vessels alone to be used as a criterion in the selection of high-yielding trees. There are other factors which exercise an equally great effect on the production of latex, such as the number of latex vessels per ring, the size of the lumen of the vessels, the pressure within the vessels, the viscosity of the latex, the rubber content of the latex and the rapidity with which the latex coagulates.

Studies were also made of the correlation between (1) yield of rubber and circumference of tree, (2) the number of latex-vessel rings and the circumference of tree, (3) the circumference of tree and thickness of bark, (4) bark thickness and number of latex vessel rings, (5) rate of growth and production of rubber. The correlation coefficients on the whole were low, the last-named giving the most positive correlation, indicating that yield is connected with physiological vigour.

In these investigations the most promising characters have been correlated with yield, but none show a sufficiently close correlation to be made a sole criterion of yield. The investigations emphasise the importance of securing a good initial growth of the trees and maintaining the growth throughout the period of production.

Vulcanisation Coefficient.—De Vries contributes a paper to the *Journ. Indust. and Eng. Chem.* (December 1921, p. 1133) showing that in a series of rubbers vulcanised so as to have the same physical properties, the quickly vulcanising rubbers combine with more sulphur, whilst slowly vulcanising rubbers combine with less sulphur than the average. He points out that this is remarkable, since artificial acceleration of vulcanisation generally reduces considerably the amount of sulphur required to vulcanise the rubber. The effect of the natural acceleration is much less pronounced than in the case of artificial acceleration.

Cultivation.—An account is given in *The Planter* (1922, 2, 72) of an important series of experiments on the connection between thorough cultivation of the soil around old rubber trees and the yield of latex. Four methods of cultivation were tried : (1) The whole area was forked 9 in. deep, (*a*) with a three-pronged or changkol fork, (*b*) with a four-pronged European fork ; (2) the whole area was changkolled 12 in. deep, leaving spaces of 5 ft. radius round each tree ; (3) and (4) were similar to (1) and (2), except that alternate rows were cultivated.

The experiments were carried out on soils of the following kinds: No. 1 red soil, No. 2 white sandy loam, No. 3 white cementing soil, and No. 4 brown loam.

In no case was an improved result obtained by the treatment mentioned, and the conclusion is drawn that although it is possible that other types of soil might give different results, the tillage of soil in plantations of old rubber trees is not a desirable measure.

Fibres

Flax.—The large increase in the area devoted to flax in Ireland during the European war was accompanied in some cases by a partial or total failure of the crop due to specific diseases caused by parasitic organisms. In this connection a study has been made of a disease of flax which had not been previously recognised, and an account of the work is given in a paper, entitled "The 'Browning' and 'Stem-break' Disease of Cultivated Flax (*Linum usitatissimum*) caused by *Polyspora lini*, n. gen. et sp.," by H. A. Lafferty, A.R.C.Sc.I., Assistant in the Seeds and Plant Disease Division, Dept. Agric. and Techn. Instruction for Ireland (*Sci. Proc. Roy. Dublin Soc.*, 1921, **16** (N.S.), 248).

The disease in question occurs in two forms, viz. (1) "browning," a turning brown of the plants which occurs rapidly, especially during moist weather, at or before the stage at which the plants are ready to be pulled; and (2) "stem-break," the fracture of the stems of some of the affected plants, usually in the region of the first node, and thus at or near the level of the soil. In both forms of the disease a fungus is present which has been isolated, studied in pure culture, and proved by inoculation experiments to be the cause of both "browning" and "stem-break." This fungus, not having been previously recorded, has been named *Polyspora lini*, n. gen. et sp. Both white-flowered and blue-flowered varieties of flax are susceptible to the disease. It has been found that diseased plants produce infected seed which is the chief, if not the only, means by which the disease is perpetuated. The fungus has been found on flax seed produced in England, Scotland, Holland, Russia, Canada, and Japan, and the disease has been reported as occurring on flax in British East Africa, and it therefore appears that it is probably present wherever flax is cultivated. It is possible, however, that, owing to differences in the climatic conditions, it may be less serious in some of these countries than it is in Ireland.

Seed should not be saved for sowing from a crop affected with the disease. It has been found, however, that when healthy seed is not available for sowing, a promising method of control is to spray the seed with a dilute aqueous solution of formaldehyde.

New Zealand Hemp.—In consequence of numerous complaints which have recently been made regarding the quality of the New Zealand hemp now being exported, Mr. Alfred Seifert, of Palmerston North, took the opportunity, during a visit to the United States last year, of interviewing cordage manufacturers and hemp brokers in that country with the object of ascertaining the defects in the fibre to which objection is made. The results of his enquiry have been published in the *New Zealand Journ. Agric.* (1922, **24**, 89).

The colour and strength of the fibre are usually regarded as quite satisfactory, but the following three faults were pointed out as requiring special attention. (1) The presence of badly cleaned (" barky " or " dirty ") tails. This is the worst defect, and is greatly objected to by cordage manufacturers, who require the fibre to have clean tails such as are always found in Manila and Sisal hemps. In order to effect this, it is necessary to sort the leaves according to length before stripping and then to use a special tailing machine or hackles on the scutcher. This would cause a little extra waste and would demand rather more labour, but would render the fibre much more attractive to the trade. (2) The presence of runners (sometimes termed " thin edges " or " ribs "). This defect spoils the appearance of the fibre. It may be caused by the stripper-drum having too much spring, by the drum being badly dressed, by uneven feeding, or by feeding leaves of unequal length. (3) The presence of " tow balls." These are probably caused by the thread being slightly broken owing to the stripper-drum being badly dressed or to uneven feeding.

The opinion is expressed that the prospects of New Zealand hemp are good, and that if prepared free from the above-mentioned defects the fibre will realise better and more uniform prices, the extra cost of preparation being well repaid by the higher returns secured.

Cotton

West Indies.—*St. Vincent.*—The *Rep. Agric. Dept., St. Vincent, for the year* 1920 contains an account of the progress of the cotton industry in St. Vincent and the St. Vincent Grenadines. The total area of land devoted

to cotton during the season under review was 7,965 acres, which was 1,332 acres in excess of that planted during the previous season. In St. Vincent 5,744 acres were under Sea Island cotton, whilst in the Grenadines 1,512 acres were planted with Marie Galante cotton and 698 acres with the Sea Island type. These areas constitute a record, and the increase was due to the high prices ruling during the previous season, when, in some cases, as much as 10*s.* per lb. was obtained. Some growers planted the crop on land which was quite unsuitable for it, whilst others grew such large areas that they were unable to give proper attention to the cultivation. This resulted in the average yield of cotton per acre being lower than in 1919.

Manurial experiments which have been carried on for several years indicate that the St. Vincent soils are much in need of potash, and show that although the application of cotton-seed meal gives increased yields, better returns can be secured by the use of potash. At the same time, it is pointed out that in order to maintain the fertility of the soil, an intelligent use must be made of pen manure, green dressings and crop rotation.

Soft rot (*Phytophthora* sp.) was present in all the fields during the latter part of the season and caused considerable damage. Some loss was also occasioned by the infestation of the cotton stainer (*Dysdercus Delauneyi*), and the work of the Department on the control of this pest was continued (cf. this BULLETIN, 1920, **18**, 300). It is recommended that at the time of the destruction of the cotton plants heaps of cotton seed or of cotton-seed meal should be placed in the fields and that these should be visited morning and evening and the insects destroyed by means of a kerosene or gasolene torch. Boiling water is sometimes used for this purpose, but the torch method is regarded as more effective.

The exports of Sea Island cotton from St. Vincent during 1919–20 amounted to 494,871 lb., of value £163,443, and of this 18,871 lb. was stained. The quantity of Marie Galante cotton exported was 85,727 lb., of which 8,187 lb. was stained.

The seed-cotton ginned at the Government ginnery gave the following yields of lint: superfine white grade, 24·4 per cent.; ordinary white, 26·7 per cent.; stained, 23·7 per cent.

St. Lucia.—The cultivation of cotton in St. Lucia is not recommended, as experience has shown that it involves considerable risk of loss. In cases, however, in which planters decide to plant the crop the Department of Agriculture affords all the assistance possible to render

the enterprise successful (*Rep. Agric. Dept., St. Lucia*, 1920). Owing to the high prices which were being realised for cotton in 1920, some attention was devoted to the crop, with the result that 4,345 lb. of Sea Island cotton and 8,948 lb. of cotton seed, of total value £867, were exported during the year.

United States.—*Meade Cotton.*—In this BULLETIN (1921, **19**, 394) reference was made to a new variety of cotton, known as "Meade," which has been developed by the Bureau of Plant Industry of the United States Department of Agriculture to replace the Sea Island crop which has been rapidly declining. Further information on this subject has now appeared in a paper, entitled "Meade Cotton, an Upland Long Staple Variety replacing Sea Island," by G. S. Meloy, Bureau of Markets, and C. B. Doyle, Bureau of Plant Industry, which has been issued as *Bull. No.* 1030 (1922), *U.S. Dept. Agric.*

The decline of the Sea Island cotton industry, owing to the spread of the boll weevil over the entire Sea Island section of the South-eastern States, is shown by the following figures giving the number of bales of this cotton produced during recent years: 1916, 117,559; 1917, 92,619; 1918, 52,208; 1919, 6,916; 1920, 1,868. It is thus evident the Sea Island cotton industry is threatened with extinction.

In considering possible means of preserving the industry, only two ways appeared open, viz. (1) the development of an early strain of Sea Island cotton which would yield profitable crops in the presence of the boll weevil, and (2) the substitution of an Upland variety which would combine the superior cultural features of this type with the production of a fibre comparable in length and fineness with that of Sea Island. The production of the Meade cotton has shown that the latter method is the more likely to give successful results.

During the five years in which Meade cotton has been grown in the South-eastern States it has given a yield at least twice as great as that of Sea Island and not less than that furnished by the short-stapled Upland varieties when grown under similar conditions. The commercial value of Meade cotton is not less than double that of the short-stapled cotton. This new cotton can be grown anywhere in the Sea Island belt under the same conditions as those under which Sea Island cotton was produced. If the same care is exercised in harvesting and ginning as in the case of Sea Island cotton, the fibre is readily accepted on the market on a par with the latter, which

it resembles so closely that it cannot be distinguished except by experts. Meade cotton has been profitably cultivated in the presence of the boll weevil, and has been found as early and prolific as the short-stapled cottons grown in the South Atlantic coast districts.

In order to produce and maintain an adequate supply of pure seed, encouragement is being given to farmers to organise on a community basis for the purpose of growing Meade cotton only and to keep up the standard of the variety by continued selection and careful ginning on a locally controlled gin. Such organisations can market their crops in large quantities of uniform fibre, and thus obtain better prices. Until such organisation can be effected, however, the best plan is for a few of the more intelligent farmers with private ginneries to produce sufficient good seed to supply the whole section.

The Bulletin gives a full description of the Meade variety of cotton and its cultivation, and contains some excellent illustrations.

Improvements in Cotton Production.—The gradual extension of the boll weevil throughout the cotton-producing area of the United States in spite of measures to check its advance has necessitated a general reorganisation of agriculture in that country. Attention has been particularly directed to the possibilities of improving production so as to reduce the injuries or compensate for the losses occasioned by the pest. As a result of these efforts, superior varieties of cotton have been developed and introduced into cultivation, cultural methods have been improved, and cotton growing has been extended into new regions where the weevil either does not exist or can do but little damage.

An account of this work and of the results which have been secured is given in a report on " Improvements in Cotton Production " by O. F. Cook, Bionomist in Charge, which has appeared as *Department Circular No.* 200 (1921), *U.S. Dept. Agric.* It is pointed out that instead of the industry being ruined or the crop greatly reduced during the period of weevil invasion, as had been anticipated, production has been maintained and even increased. Cotton cultivation was abandoned in a few of the more humid districts where the crop was uncertain and was most exposed to weevil damage, but more cotton is now grown in the drier regions of central and western Texas, and a new branch of the cotton industry has been developed in the irrigated valleys of California, Arizona and New Mexico which have not been reached by the boll weevil.

New varieties of cotton have been produced which

yield superior fibre and are earlier and more productive than those which were grown before the arrival of the boll weevil. Special reference is made in the *Circular* to the advantages to be derived from early varieties; the suppression of vegetative branches with the production of a single upright stalk; the adaptation of varieties to new or special conditions; the improvement of seed supplies; the organisation of farming communities to grow a single variety; and the improvement of the commercial system.

Boll Weevil.—The introduction of this destructive pest into the United States from Mexico took place in 1892, when the insect crossed the Rio Grande near Brownsville, Texas. During the first ten years after its arrival the pest spread at the rate of 5,640 square miles per annum; between 1901 and 1911 the annual increase of infested territory was 26,880 square miles, and in 1916 it reached 71,800 square miles. At the end of 1921 over 600,000 square miles had been invaded, leaving only about 105,000 square miles of cotton-producing territory which had not become infested. The weevil is now prevalent over about 85 per cent. of the cotton belt, this area producing 94·6 per cent. of the total cotton crop.

A general account of the boll-weevil problem has recently been issued by W. D. Hunter, Entomologist in Charge, and B. R. Coad, Entomologist, Southern Field-crop Insect Investigations, as *Farmers' Bulletin No.* 1262 (1922), *U.S. Dept. Agric.* It deals with the history of the insect in the United States, the damage it has caused in different regions, the reasons for local variations in damage, the indications for the future, the habits of the weevil so far as they affect control measures, and the means of reducing the injury.

The following methods of control are now recommended. (1) The destruction of the cotton plants in the early autumn. (2) The destruction of the hibernating weevils as far as possible by cleaning up the fields during the winter; the weevils can hibernate in any trash or rubbish, and it is therefore a good plan to burn over or clean up such places, especially fence rows and ditch banks. (3) If poisoning is not to be practised, planting should be done in fields situated where weevil damage will be at a minimum. If poisoning is to be undertaken, the fertile soil adjoining hibernation quarters of the weevil should be planted, and efforts should be concentrated on the thorough control of the pest in these fields. (4) The land should be prepared early and thoroughly so as to obtain an early crop. (5) The best distances between the rows and between the

plants should be determined by experiment, and, when this has been done, every effort should be made to secure a good growth of plants at the most suitable spacing. (6) An early crop should be ensured by early planting of early maturing varieties, and by manuring when necessary. (7) The production of an early crop should be assisted by careful chopping and early and frequent cultivation. (8) If conditions seem suitable, the destruction of the weevils should be effected by poisoning with powdered calcium arsenate (cf. this BULLETIN, 1920, **18**, 448).

FORESTRY AND FOREST PRODUCTS

Trade Names for Indian Timbers.—At a Utilisation Conference of Indian Forest officers, held at Dehra Dun in January 1922, Mr. A. Rodger of Burma read a paper on the advisability of having a set of standard trade names for all Indian timbers likely to find a market outside India. The Conference appointed a sub-committee to draw up a list of suitable trade names, and the list of names provisionally accepted by the Conference is published in the *Indian Forester* (1922, **48**, 135). Criticisms and suggestions have been invited from forest officers, and it is proposed to use the list of names at the Empire Exhibition to be held in 1924. The tentative list as published includes 163 different species, arranged under 154 trade names. No timbers belonging to different genera have been given the same trade name, except in the cases of the Burmese species *Pentacme suavis* and *Shorea obtusa*, for which the name Burmese sal is proposed, as these timbers are virtually indistinguishable and locally have been considered equally useful. Closely similar timbers, belonging to the same genus, have, however, been grouped under the same name where it appeared to the Conference that there was not sufficient industrial difference in their use to justify allotting a separate name to each species. The names given have been selected with a view to avoiding confusion with existing trade names by taking either the most easily pronounced vernacular name or an English name not already used for any other species. It is interesting to note that the list does not include any of the new trade names which were applied to a number of valuable Indian woods exhibited by Messrs. W. W. Howard Bros. & Co. at the Empire Timber Exhibition held in London in 1920, and employed by Alexander L. Howard in a paper on the timbers of India and Burma read recently before the Royal Society of Arts (*Journ. Roy. Soc. Arts*, 1922, **70**, 237).

The Tuart Forest of Western Australia.—An interesting account of the tuart (*Eucalyptus gomphocephala*) forest, situated to the north-east of Busselton in the South-Western District of Western Australia, is given in the *Australian Forestry Journ.* (1921, **4**, 362). This forest, the only one of its kind in existence, occupies a strip of limestone country, less than two miles wide, stretching between the Capel and Sabina rivers for a distance of some 12 miles and running parallel with the coast 2 or 3 miles inland. The greater portion of the area, viz. 5,258 acres, is dedicated as State Forest, and comes under a working plan recently brought into operation by the Forest Department. A striking feature of the forest is the total absence of young tuart in nearly all parts. All the trees seen by the writer of the article were over 50 years old, and many were of far greater age. The absence of regeneration of tuart is attributed to the continual grazing which has been carried on for the past forty years, and to the repeated fires consequent on such grazing. Only on certain fenced areas in the bush, where grazing has been to some extent restricted, are any young tuarts to be seen.

The main object of the working plan laid down for the tuart forest is to prevent the overcutting of the timber. This will be assured by limiting the amount cut annually to the amount added annually to the growth of the forest, so that a sustained yield will result. Measurements extending over three years on a five-acre plot indicate that the probable increment in girth of the tree is 0·7 in. per annum, which means that it takes approximately 100 years for tuart to reach maturity. The forest has been marked into compartments, and the trees will be marked by the foresters for cutting, the useless and over-mature trees being removed first, with the exception of those intended to be used as seed-trees for regeneration purposes. It is expected that once normal conditions of the forest are restored by protection from grazing and fires the tuart will regenerate itself naturally. At the same time experimental work in the growing of tuart, both in nursery beds and broadcasting *in situ*, is being undertaken; but artificial regeneration is only to be looked upon as a last resource. In order to restrict grazing, a fence is to be placed round the whole of the external boundary of the forest, animal grazing leases being granted on certain specified areas. For the prevention of fire, breaks half a chain wide have been cleared right round the external boundary and a start has been made with the clearing of cross breaks of the same width which will ultimately subdivide the forest into compartments of 250 acres or more,

One of the chief enemies of the tree is a weevil, *Haplonyx tibialis*, which destroys large numbers of flower buds and so diminishes the seed crop. Large quantities of seed are destroyed by ants.

Tuart timber is described as one of the densest and toughest in the world. It is in great demand by the State Railway Department for use in the construction of rolling stock and for some years past the cutting of tuart, except for departmental purposes, has been forbidden on Crown lands. For the purpose of economical conversion of the timber, the Forest Department has erected a mill in the forest close to Wonnerup Siding, and a turnery plant is to be installed in order that all branchwood, faulty butts and small pieces of timber may be utilised for making spokes, tool handles, bobbins and other small articles.

A Sawfly Injurious to Young Pines.—*Farmers' Bulletin* 1259 (1922), *U.S. Dept. Agric.*, gives an account of Leconte's sawfly (*Neodiprion lecontei*), the larva of which is a serious enemy of pines in nurseries, parks and reforesting areas in the Eastern United States. The insect is common on the scrub pines and is a constant menace to the more valuable species. The larvæ occur in clusters and frequently completely defoliate young trees, either killing them outright or so weakening them that they are unable to withstand the attack of secondary enemies. The pest can be controlled in nurseries and parks, when the infestation is heavy, by spraying with lead arsenate at the rate of 2 lb. to 50 gallons of water, or in cases where the attack is not so severe by hand methods, such as knocking the larvæ from the trees and crushing them. In larger and less accessible areas, where it would be impracticable to attempt control by spraying, it is recommended that rangers and lumbermen should destroy the colonies of larvæ whenever they are found.

MINERALS

Aluminium

Russia.—According to an account of the aluminium-ore resources of Russia, published in the *Mining Journ.* (Nov. 26, 1921, p. 883), the alunite shales at Saonezoja (Olonetz), the clays in the Borowitz district (known as *suchar* and containing 40 per cent. alumina) and the nepheline rocks rich in aluminium in the district east of Lake Imandra are not of any value under present conditions. Of greater importance are the deposits of pure bauxite and similar rocks lying 13 to 40 miles south-east of the town of Tischwin

in the Novgorod district. To the north these deposits extend as far as the village of Seglar, west to the edges of the Devonian and Coal Measures, and south to the village of Rudwaya Gorku ; the eastern limits have not yet been defined. Further prospecting is expected to show that the deposits extend northwards into the Olonetz and Archangel provinces. The area of the deposits at present defined is said to be about 88 square miles, and the bauxite is irregularly distributed over this area, mostly in the form of pockets. Deposits near the Wolozba River were discovered as long ago as 1882, but were ignored until the war, when a little superficial work was done.

Asbestos

Australia.—According to *Chem. Eng. and Min. Rev.* (Jan. 5, 1922), two new discoveries of asbestos are being opened up in Western Australia, one at Sherlock station, 14 miles from Whim Well and 35 miles from Roeburn, the other on Strelley River, about 39 miles from Carlindi. The former is stated to be chrysotile traversing two hills of serpentine, and a large proportion of the fibre is stated to be up to 1½ inches in length, some reaching 4 inches. The Strelley River deposit has been reported on by R. C. Wilson, Assistant Government Mining Engineer, as follows: "Two shafts 130 ft. apart have been sunk in the main line of lode ; one of these is 30 ft. in depth and the other 20 ft. About 36 in. of the lode is exposed in these shafts, which might average 30 per cent. of fairly good fibre up to ¾ inch in length." The proximity of this deposit to the railway is of advantage in transporting fibre to Fremantle.

Rhodesia.—The *S. Afr. Min. and Eng. Journ.* (Nov. 26, 1921, p. 447) reports extensive discoveries of asbestos fibre seams in the Mashaba district, Rhodesia. The field has been examined by experts who report a strike of six miles from the Olga claims towards and through the Sapientia extensions. Some preliminary work has been done in opening up the seams with satisfactory results. The fibre, some of which has been put through a mill, is stated to be of exceptionally fine quality.

Russia.—According to *Russian Information and Review* (Dec. 15, 1921, p. 129), approximate figures for the total Russian output of raw asbestos in recent years are as follows :

	Tons.		Tons.
1909	7,500	1918	530
1913	25,000	1919	470
1916	11,000	1920	1,000

The decline in output during the war is ascribed to the mobilisation of the miners. Formerly the work was done by unskilled peasants during the intervals when they were not needed in the fields, the " mines " being merely pits and surface cuttings. These are now practically exhausted so that future development will call for modern machinery and mining methods which will necessitate the employment of skilled workers. One district, the Alapaev, has been leased to an American company, but the remainder, chiefly concentrated in a district 40 miles wide in the Urals, are under a single directorate or " trust," which will also control the five electric power stations connected with the mines, the mills in which the ore is treated, and factories turning out finished products, such as rope and insulating sheets. It is estimated that, roughly, 65 tons of rock yield 4 tons of " ore " from which 1 ton of pure product is obtained.

Gypsum

Ireland.—According to *U.S. Commerce Report* No. 197 of August 24, 1921, bores sunk near Carrickmacross, Co. Monaghan, Ireland, have proved the existence of a large deposit of gypsum. At Lishaboe, Co. Meath, a body of gypsum estimated at a million tons has been located whilst boring for coal. A factory capable of producing 25 tons of plaster of Paris per day is being erected and a large quantity of high-grade gypsum has been mined. In addition, a number of large blocks of very ornamental alabaster have been obtained.

Iron

Sweden.—According to the *Min. and Sci. Press* (March 4, 1922), the iron-ore deposits of Kirunavaara in the extreme north of Sweden, well known for their richness in iron and comparative freedom from impurities, are calculated to have contained originally 1,200 million tons of ore, of which about 30 million tons have been extracted. About 2½ miles from Kirunavaara is the Luossavaara iron-ore mountain; where mining commenced in 1921. The mine is State-owned, but the right to exploit it up to 1930 has been granted to two private companies, subject to certain working regulations and payments to the State. The mountain rises to a height of about 660 ft. above the level of the neighbouring lake of Luossajärvi, which is about 2,450 ft. above the sea-level. Geologically the conditions resemble those of Kirunavaara, but the ore appears to contain less phosphorus. The percentage of iron in the

ore has been shown to range from 65 to 70 and that of phosphorus from 0·004 to 4·2. The exposed portions of the deposits cover about 30,000 sq. yds., and the quantity of ore above the level of Lake Luossajärvi is calculated at 22½ million tons. On the Kirunavaara side close to Luossajärvi diamond drilling has shown that iron ore extends to a depth of 1,000 ft. below sea-level.

Mineral Pigments

Australia.—In the *Chem. Trades Journ.* (December 3, 1921, p. 694), it is noted that in the course of a study of the triassic rocks north of Cooktown, Queensland, Joseph Campbell had found valuable deposits of oxides and ochres. These are principally in the neighbourhood of Cape Flattery, where there is alleged to be scope for a considerable industry in earth colours. Analysis shows a high percentage of iron oxide, but its physical condition, on which the quality of an ochre chiefly depends, is not stated. Samples of quartz sand washed from these pigment deposits in the course of refining have been investigated recently at the Imperial Institute, and found to be suitable for the manufacture of glass, for such purposes as the production of pale-tinted bottles.

According to the *Min. Journ.* (Nov. 19, 1921, p. 852), a large deposit of copiapite (a hydrated basic sulphate of iron, rarely met with) has been located in the north-east of South Australia. It appears to have resulted from the oxidation of marcasite, and occurs as a lode in blue slate. On ignition, the yellow copiapite yields a rich Venetian red, and a company has been formed to open up the deposit as a source of pigments and sulphur.

Monazite

Uganda.—According to the *Ann. Rept. Geol. Dept., Uganda*, for 1920, monazite is widely distributed in the Protectorate, but is known to occur in quantity only in two localities, one of which is conveniently situated as regards transport and mining facilities.

Nickel

Canada.—In the *Eng. and Min. Journ.* (Oct. 8, 1921, p. 590) it is reported that nickel has been discovered in the ore of the Gabbro Copper Mine, on the west coast of Vancouver Island. In a zone having a maximum width of over 30 ft., entirely in gabbro and recently uncovered, there was shown to be much copper and nickeliferous

pyrrhotite. A sample of the pyrrhotite was found to contain 5 per cent. of nickel.

Potash

United States.—During 1921 the output of crude potash salts in the United States amounted to over 18,200 short tons containing 7,618 short tons of pure potash (K_2O). About 79·5 per cent. of this was obtained from natural brines, and the remainder from cement mills, blast furnaces and sugar refineries. No potash was reported as having been produced during the year from alunite, silicate rocks, kelp or wood ash (*American Fertilizer*, April 22, 1922, p. 31).

IMPERIAL INSTITUTE MONOGRAPHS ON MINERAL RESOURCES: SUPPLEMENTARY INFORMATION. MANGANESE ORES, OIL SHALES, PETROLEUM

In the last issue of this BULLETIN (1922, **20**, 111) a summary was given of recent information relating to Chromium Ore, Coal and Lead Ores, supplementing the information contained in the Imperial Institute Monographs on Mineral Resources dealing with these materials. In the following pages a similar summary is given relating to Manganese Ores, Oil Shales and Petroleum. Particulars relating to the subjects of other Monographs (Platinum Metals, Silver Ores, Tin Ores and Tungsten Ores) will appear in the next number of the BULLETIN.

MANGANESE ORES

The world's chief sources of manganese ore are India, Brazil and Russia, countries in which are the largest and richest deposits, an abundant supply of cheap labour, and, consequently, low costs of production. At the present time India is the chief source of ore, and Brazil comes next. Russia was formerly important, but now is almost negligible as a country of supply owing to her political condition. The principal deposits at Tchiatouri in the Caucasus were, after the armistice, under the control of the Republic of Georgia, which gave the monopoly of exporting ore to a group of foreign and Georgian companies known as the "Société d'Exportation de Manganèse de Tchiatouri," an organisation generally known by the abbreviated name "Temo." The Soviet of Russia afterwards occupied the country of Georgia, and eventually confirmed the right of

the Temo to the deposits, which in future will be worked by the Dutch firm of Vlessing & Co. It is stated that nearly a million tons of ore, of which 35 per cent. is washed, is stacked ready for shipment on the mines in the Tchiatouri district, and that a further 150,000 tons or so is stored at the port of Poti on the Black Sea.

The Brazilian deposits are being largely developed by English and American capital, and the output is mainly sent to the United States.

The output of India is mostly exported to England.

Unfavourable conditions have recently affected the manganese industry in the same way as other metalliferous industries. There was an improvement in production in 1920 compared with 1919, but a set-back was experienced in 1921 owing to the depressed state of the steel industry.

In the United States, according to Jenison (*Eng. and Min. Journ.*, Jan. 27, 1922, p. 89), the imposition of a duty of 1 cent per pound of metallic manganese contained in all foreign ore and concentrate is being considered, with the object of encouraging home production. This duty would be equivalent to $4 per ton on Russian, Indian and Chilean ore, and $3 to $4 on Brazilian ore.

According to the *Bd. of Trade Journ.* (Feb. 20, 1919, p. 253), the scarcity of manganese ores in Germany during the war was met by substitution of calcium carbide for a large portion of the manganese used in the Thomas process of steel-making. Subsequently a process which had been abandoned, owing to the abundance and relatively low price of manganese, was revived in a greatly improved form, and reduces the quantity of manganese required in the Thomas steel process to 0·2 per cent. of 30 per cent. ferro-manganese. This improved method has been placed free at the service of the Federation of German Smelters, and is therefore available throughout Germany.

Gold Coast.—Recent development of the deposit at Dagwin in the Gold Coast, referred to in the *Monograph* (p. 55), was described in the 1921 report of the Fanti Consolidated Mines, Ltd.; an annual output of 200,000 tons of ore was considered possible in the near future, subject to adjustment of the railway rate to Sekondi and to the provision of better steamer loading facilities there. The 1916–19 outputs of ore were 4,275, 30,275, 29,124 and 35,189 long tons respectively.

Sierra Leone.—It is stated in *Geol. Survey Rept., Sierra Leone, for* 1918 *and* 1919, that manganese ore deposits have been found in the Giehun area of the colony in the form

of a black coating, up to half an inch in thickness, on masses and residual boulders of certain rocks. The ore is believed to be lateritic in origin, and probably has no immediate commercial importance. Near Freetown nodules of manganese ore are found in the laterite of the coastal plain.

Canada.—The various deposits of manganese ore in Canada are described in a section of the *Final Report of the Munition Resources Commission* of Canada, issued in 1920. Generally the deposits are not of great extent or of high-grade, only a small proportion of the ore being suitable for making ferro-manganese.

The bog manganese ores of Canaan River, Westmoreland Co., New Brunswick, were amongst those examined, and the *Report* mentioned above supplies new information. The bogs are on valley slopes below the orifices of a series of mineral springs, with which the manganese is genetically connected. The water from the springs is apparently depositing manganese dioxide on an original surface of sand, clay and gravel. The deposits spread out in a fan-like manner from the vents of these springs and gradually thin out to nothing at the lowest extremity. The thickness of the workable deposits varies from about a foot to upwards 7 ft., the thicker portions occupying depressions in the original surface. The ore as quarried contains 70 to 80 per cent. of moisture and some organic matter, from which it must be freed by drying and calcining. Briquetting of the calcined material appears to be necessary to produce a marketable product.

The quantity of ore available is estimated at 43,500 tons, which, after treatment, produces a material of moderate grade, but the cost of treatment is too great for profitable exploitation.

In the *Ann. Rept. of the Minister of Mines, British Columbia for* 1918, pp. 296–298, G.C. Mackenzie describes the result of an examination of the newly-discovered manganese deposits at Shaw Creek, near Hill 60, Cowichan Lake. The deposits are on the Black Prince group of claims, and occur in a belt of cherty, jasperised quartzose rock of a character similar to the rocks found at Hill 60. They are in part residual in character, but in one case the ore apparently fills a fissure in the cherty rock. A branch of Shaw Creek, which flows through the manganese area, would provide water both for dressing the ore and for generating the necessary power. Detailed assays show that the material has no market value in the undressed condition. The extent of the deposits is unknown. Quito, the railway terminus, is 28 miles from the property.

Until transport is improved the value of the deposits is doubtful.

Australia.—A report by A. Montgomery, the State Mining Engineer for Western Australia, published in 1920, on the *Manganese Deposits at Horseshoe Range, Peak Hill Goldfield*, states that these deposits have been known for over twenty years, but have not previously been officially recorded. Two deposits exist: one, the southern ore-body, being much larger than the other, which is situated about a mile further north. Each appears to be a sheet of superficial ore, and is of unknown thickness. Montgomery considers, however, that the deposit may in some cases reach a depth of 50 ft. or more, although elsewhere it might be quite thin.

The area of the southern body is about 91,000 sq. yd., and allowing 9 cub. ft. to the ton, this would give 91,000 tons for each foot in depth. Montgomery considers it safe to calculate on an average depth of 12 ft., making a total, on the above basis, of over a million tons of ore. The northern ore-body would probably yield about 250,000 tons of ore. The ore contains on the average about 43 per cent. of manganese.

Greece.—In *Peace Handbook No.* 21, pp. 71–73, manganese ores are stated to occur in the mining area of Khalkidike, Macedonia. Manganese is also present in considerable quantities at Liposa and Varvara near the shores of the Gulf of Orfano, and at Horado on the nothern edge of the Beshik Dagh.

Hungary.—An abstract of an article in *Stahl und Eisen* on the recent important discoveries of manganese ore near Nagyvazsony and Urkut in West Hungary has appeared in this BULLETIN (1921, **19**, 415).

Spain.—In discussing the origin of the pyrolusite deposits in the Sierra de Marchamonao, Málaga, Alfonso de Alvarado (*Bol. del Inst. Geol. de España*, 1920, **41**, 20) considers that the formation of ferrous and manganous carbonates followed partial dissolution of limestone, these carbonates being oxidised later in the upper zone of the fractures. The deposits have been worked to some extent recently.

Yugo-Slavia.—According to information given in *Peace Handbook, No.* 20, p. 92, important deposits of manganese ore are reported near Gradsko Veles and Kumanovo, and also in the Platchovitska Mts., Serbia. No recent mining has

been reported. Further particulars of manganese deposits in Yugo-Slavia have appeared in this BULLETIN (1921, **19**, 416).

China.—Large deposits of good manganese ore occur near the city of Canton (*Min. Ind.*, 1920), but development is hindered by high transport costs.

Sumatra.—Manganese ore deposits, according to *Peace Handbook, No.* 83, p. 48, have been found on the island of Banka, but no production has been recorded.

Portuguese India.—The manganese deposits of Goa are near Marmagão, and according to *Peace Handbook, No.* 79, about twenty manganese mines were working in 1920.

Tunis.—According to *Suppt.* 72*a*, 1920, *U.S. Comm. Repts.*, an important deposit of manganese ore is being exploited at Ghardimaou, near the Algerian frontier of Tunis, where the ore mineral is pyrolusite with an average metal content of 45½ per cent. Other deposits, not yet exploited, are known in the same locality. The production of ore from the Ghardimaou deposits in the years 1915–19 were 1,460, 2,027, 3,850, 830 and 1,313 metric tons respectively.

Costa Rica.—According to *Min. Ind.*, 1919, the manganese ore deposits of Costa Rica had yielded to date 18,000 tons of ore from three deposits that lie in an area of about 1,000 ft. square at Playa Real, and it is estimated that 10,000 to 15,000 tons remain unmined. The ores are found associated with free silica, and careful sorting is necessary to produce a material assaying more than 45 per cent. of manganese.

Mexico.—According to *U.S. Comm. Rept. No.* 288, 1920, a manganese mine, situated on the Gulf of California, at Punta Aguja Peninsula, was yielding 200 tons monthly of high-grade ore, averaging about 48 per cent. of manganese. The product is at present being shipped to Chicago, which involves heavy freight charges and customs dues, and therefore only high-grade ore can be profitably mined. There is a large tonnage of lower-grade material, and plans are under consideration for transporting the ore by water either to San Francisco, or via the Panama Canal to New York.

Brazil.—Horace E. Williams has briefly described the deposits of manganese ore near Volta Grande, Minas

Geraes, Brazil (*Eng. and Min. Journ.*, Jan. 18, 1921, p. 1089), in which occur both psilomelane and graphite, and a short summary of his article has appeared in this BULLETIN (1921, **19**, 417).

Chile.—According to H. A. C. Jenison (*Eng. and Min. Journ.*, Jan. 27, 1922, p. 89) a French syndicate has acquired the Marquesa deposits in Chile, and is equipping the mine to produce 300,000 tons of ore per year. The percentage composition of the ore is: manganese, 50; silica, 8·5; iron, 1·5. Its phosphorus content is less than 0·2 per cent., and the cost of production is between \$3·50 and \$4·00 (U.S.) at Chilean port.

Ecuador.—According to *Min. and Sci. Press* of April 12, 1919, manganese ore deposits are being worked at San Antonio, Pinchincha Province, Ecuador. The deposits are in a region of volcanic rocks partly covered with sand, and the principal ore-body is a blanket deposit, 3 to 9 ft. thick, with an average content of 46·36 per cent. of manganese, 6·4 per cent. of silica and a little copper and phosphorus.

Uruguay.—It is reported in *Bull. Pan-American Union* (March 1919, p. 336) that deposits of manganese ore of considerable extent exist in many parts of Uruguay. One of the most important is in the department of Rivera, near Zapucey Creek, there being two veins from which, according to estimates, 80,000,000 tons of ore may be extracted.

OIL SHALES

Both microscopic and chemical researches, undertaken in this country and in the United States, are helping to solve the problem of the economic distillation of oil shale. Reinhardt Thiessen has shown that the oil shales of the Eastern United States are very similar microscopically to those of Scotland, whilst those of Colorado, Utah, and other Western States differ considerably from the two former microscopically, as well as in composition, structure, and physical characteristics, and require different treatment to obtain the desired result. He considers that microscopic examination may become a most important aid in the valuation of an oil shale.

Researches by R. H. McKee and E. E. Lyder have shown that, in distillation, the primary product of decomposition is a semi-solid bitumen which is formed at a temperature of between 400° and 410° C., and that

petroleum oils are produced from shales by a cracking process similar to the well-known phenomena of the cracking of petroleum oils.

Great Britain.—The development of the Norfolk and Kimmeridge oil shales must remain in abeyance until a satisfactory retort for distilling them has been found. Owing principally to the low price of oil and the high price of labour and materials, the Scottish shale-oil industry has for some time been at a low ebb, but it is believed that operations will shortly be extended in the shale fields.

Reports have appeared of the results of low temperature carbonisation tests of Norfolk and Kimmeridge shales made with an apparatus of the same design as the Freeman multiple retort, using the Freeman precision automatic temperature control, and the results were 41·32 gals. and 47·76 gals. of oil per ton of raw shale, obtained at the economical maximum temperatures of 360° C. and 370° C. respectively (*Petroleum Times*, April 9, 1921, pp. 416–417).

Union of South Africa.—Discoveries of oil shale, which may prove of great value, have been made on the farm Maviriestad, S.E. of Ermelo, Transvaal, as well as in Griqualand West, Cape Province. Particulars of these discoveries, and of recent developments at Underberg, Impendhle County, Natal, taken from *South African Min. and Eng. Journ.* (July 9, 1921) and *South African Journ. Indust.* (May 1921) respectively, were given in this BULLETIN (1921, **19**, 417).

The Royal-Dutch interests have taken an option on extensive deposits in the Pongda Bush, Utrecht district, Natal, acquired by the African Oil Corporation; a recent test of the shale gave 40·6 gals. of oil and 57 lb. of ammonium sulphate per ton. The oil carried 1·71 per cent. of sulphur.

Canada.—Oil shales of Upper Devonian age are exposed in Northern Ontario in the neighbourhood of the Mattagami and Abitibi Rivers. According to C. V. Alderson (*Quart. Colorado Sch. Mines*, 1921, **16**, *Suppt.*, 4, p. 33) samples from the latter yielded from 87 to 132 gals. of oil per ton.

According to the *Ann. Rept. of Minister of Mines, British Columbia*, 1920 (p. N. 34), the oil-shale deposits on Graham Island of the Queen Charlotte group were being examined.

The Albert series of shales in New Brunswick is estimated to contain at least 60 million tons of oil shale (*Summ. Rept. for* 1919, *Canada Geol. Surv.*, Pt. F., p. 1).

Australia.—In Australia the principle of firing a kerosene shale seam *in situ* is being tried on a property at Newnes, New South Wales (*Chem. Eng. and Min. Rev.*, Nov. 5, 1921, p. 49), but hitherto, it seems, without entire success on account of the wet condition of the old mine.

New Zealand.—According to C. V. Alderson (*Quart. Colorado Sch. Mines*, 1921, **16**, *Suppt.* 4, p. 32), a company has been prospecting the Orepuki oil shale deposits by diamond drilling and has discovered four layers of shale, each between 4 and 5 ft. thick and containing an available tonnage of 1,000,000 tons. A test on 57 tons of shale at the Pumpherston Works, Scotland, gave 38·41 gals. of oil and 19·12 lb. of ammonium sulphate per ton. Fractionation of the oil gave the following percentages: kerosene, 25·92; gas oil, 3·07; medium oil, 4·05; lubricating oil, 17·55; hard paraffin (M.P. 119·5° F.), 19·03; soft paraffin (M.P. 86·5° F.), 1·08; loss in refining, 29·3.

Esthonia.—It is stated in *U.S. Comm. Rept. No.* 17 (Dec. 26, 1921, p. 1028) that up to the present four concessions, covering 15,300 acres, have been granted to Esthonian concessionaires, and three, totalling 36,900 acres, to foreign interests. The largest concession (24,700 acres) is held by a Belgian syndicate, and the remaining two by British or British-controlled companies. A concession to cover 33,500 acres is at present under negotiation with an English syndicate. It is understood that the Esthonian Government will receive shares in the enterprise.

During 1920 approximately 48,000 long tons of oil shale were mined by the aid of steam shovels, 500 men being employed.

Some of the oil shale is being used as fuel in the Port Kunda Cement works, the ashes being utilised in connection with cement manufacture, and some as fuel in the Reval gas works. The Esthonian Government is perfecting plans for an oil shale distillation plant.

According to C. V. Alderson (*Circular, Colorado Sch. Mines*, 1921), recent investigations by Pogrebov show that the amount of shale north of Jôhvi and Kohtla is 9,000,000 tons per square mile and its thickness is 42 ft. Winkler's estimate of the amount of oil shale near the surface between Walgejôgi and Narova was 129,000,000 tons. Production of oil shale in Esthonia has been as follows: 1918, 18 tons; 1919, 10,584 tons; 1920, 50,685 tons; 1921 (estimated), 90,000 tons. A retort of the type of that of the Julius Pintsch Co. of Berlin is in use. Ammonium sulphate is not produced, as the shale carries only 0·4 per cent. of nitrogen.

Germany.—According to the *Eng. and Min. Journ.* (April 23, 1921, p. 713), the Würtemberg deposits are to be exploited by a company which will have the active support of the Government. In some parts of the Jura Mountains in Bavaria a peculiar kind of oil shale has been discovered which yields 6 per cent. of oil. The Bayerische Mineraloelwerke, referred to in the *Monograph* (p. 56), have erected retorting and refining plants in Upper Franconia, and operations will be conducted over an area of 2,700 acres. The oil produced is stated to be equal in calorific value to that of the more inferior grades of German brown coal.

Palestine.—In the *Chem. Trade Journ.* (Nov. 5, 1921, p. 566) it is stated that in the Yarmouth Valley, Northern Palestine, are found large quantities of oil-impregnated shale. When burned this shale leaves a fine quality of lime, which, when slaked, is suitable for building purposes. The Germans extracted oil from the shale during the war.

Yugo-Slavia.—The oil-shales of Serbia, referred to in the *Monograph* (p. 57), have been more fully described in this BULLETIN (1921, **19**, 418) from information taken from the *Report on the Geology and Mineral Resources of the Serb-Croat-Slovene State* by D. A. Wray, published by the Department of Overseas Trade, 1921.

PETROLEUM

One of the most noticeable results of the recent disastrous coal strike in Great Britain was the extensive conversion of power-generating machinery to enable oil to be used instead of coal, notwithstanding the fact that practically all the oil must be imported. At the present time over 90 per cent. of the British Navy is using oil, and according to the *Annual Report* for 1920–21 of *Lloyd's Register of Shipping* the registered gross tonnage of vessels fitted to burn oil increased from 1,310,209 in 1913 to 12,796,635 in 1921. The *Report* states that the consumption of coal by steamers in existence which are now fitted to use oil fuel would amount to about 20,000,000 tons per annum, or about 8·7 per cent. of the coal mined in the United Kingdom in 1920.

Petroleum Mining.—Contrary to former experience it has been lately shown in various oil-fields of Mexico and the United States that the diamond drill can be successfully used in petroleum mining. An article by J. S. Mitchell

(*Eng. and Min. Journ.*, Jan. 7, 1922, pp. 18–19) shows how economical the diamond drill really is, and that it is particularly well suited to deep prospecting, and in the drilling of producing wells, where a casing of 4 in. is sufficient for production. In order to control high gas or oil pressures, when drilling or removing rods, an oil saver or packing box, provided with a series of cup leathers designed for high pressure, is used. The rods, having flush joints, pass through the packing box, making a safe, tight joint.

The first producing oil-well ever brought in, in any field, with the diamond drill was successfully completed last December in Mexico. It is 2,153 ft. in depth, and has an estimated production of 1,200 barrels daily. For the first 1,400 ft., the ordinary rotary system, with a fish-tail bit, was used, the diamond drill penetrating the last 753 ft. The hole drilled is 4 in. at the top and 3½ in. at the point of completion (*Mining Mag.*, Feb. 1922, p. 123).

Scotland.—According to information given by the Secretary for Mines in the House of Commons on May 15, 1922, as stated in *The Times* of May 16, 1922, in answer to questions, oil was struck on May 6 in the D'Arcy well, near Dalkeith, at a depth of 1,810 ft. The oil-bearing formation was penetrated to a depth of 10 ft., and by May 9 the oil had risen 170 ft. in the bore-hole. The oil is said to be of excellent quality, with a high percentage of petrol, kerosene and lubricating oil.

An article on the "Structural Conditions in the Edinburgh Oilfield," by H. P. D. Hills, has been published recently (*Petroleum Times*, May 27, 1922, pp. 733–734). It appears that the discovery well at D'Arcy is on the summit of a structure known locally as the Roman Camp anticline, which separates the basins of the Dalkeith and East Lothian coal-fields. The axis has an almost north and south trend and plunges in these directions, so that it really forms an elongated dome with a closure of nearly 1,000 ft. at the Binney sandstone horizon, which is a bed of the oil-shale group, belonging to the Avonian division of the Carboniferous system. The minimum area on the fold likely to be productive is a strip of ground about three miles in length, and, on an average, one mile wide. The Roman Camp anticline is the only favourable structure of any size which involves the beds here proved to be petroliferous. The Carboniferous rocks have been entirely stripped from the Pentland anticline, west of the Dalkeith coal-field, while the folds in the oil-shale fields, which lie to the west of Edinburgh, are all of small size. The unsuccessful test-well at West Calder was located on

what appeared to be the most favourable of the smaller structures, but underground an entirely unsuspected development of volcanic rocks was met with. This failure to penetrate petroliferous beds, however, does not preclude success on similar small structures elsewhere.

India.—The oil refinery which was stated in the *Monograph* (p. 21) as being built at Rawal Pindi, Punjab, was opened early in 1922. It has a daily capacity of 65,000 gallons of crude oil. The number of wells now working in the new Khaur oil-field of Northern Punjab is stated to be 23, and it is understood that refined products will shortly appear on the market (*Times Tr. Suppt.*, Feb. 18, 1922).

According to E. H. Pascoe (*Mem. Geol. Survey, India*, 1920, **40**, Pt. 3), the main seepage of oil in the Khaur oil-field lies half a mile north of Khaur, and was discovered by E. S. Pinfold. It is 100 sq. yards in extent and is situated near the crest of the Khaur dome. All the seepages of this locality are found in Murree beds. It is possible that the oil has migrated from Nummulitic beds below. By the end of 1917, 5 wells had been drilled in the area, 2 to a depth of 1,600 ft. It was afterwards found that wells located near the summit of the dome obtained workable productions from shallow sands within 400 ft. of the surface. A more prolific sand occurs at a depth of 450 to 500 ft. The deeper wells are located down the flanks or along the pitch of the dome, and have proved moderate producers from sands down to 1,600 ft. In all wells yet drilled, the value of the sands shows a fairly constant increase with increasing depth.

The oil and the water sands, examined by Pascoe in 1920, are similar both to each other and to those of Burma, and the flow is steadier and more uniform than it is in the Burma fields. The heaviest oil was obtained from the seepage, and has a specific gravity of 0·934. In sands down to 500 ft. the specific gravity varies from 0·894 to 0·876; in still deeper sands it varies between 0·877 and 0·840.

In the Dhulian area, 7½ miles W.S.W. of Khaur, there is a dome of about the same length as the Khaur dome, but broader and flatter. There are no oil seepages here, but there are two or three *salses*, or mud volcanoes, which emit small quantities of gas and salt water. Drilling is being carried out as the structure is favourable. The field is near a proved oil-bearing area, and its position is auspicious with regard to the general tectonics, which it shares with the Khaur area.

Egypt.—Further particulars of the Hurghada oil-field, referred to in the *Monograph* (p. 27), are given in *Petroleum Research Bull. No.* 6, 1920, *Ministry of Finance, Egypt*; and *Journ. Inst. Petr. Technol.* (1921, **7**, 394). Oil at Hurghada occurs in two horizons; the one (lighter) associated with a flint conglomerate below gypsum, of Miocene age; the other (heavier), in fine Cretaceous shales and sands, from 230 to 330 ft. below the flint conglomerate. The same oil series is believed to extend to the Abu Shaar el Qibli (Black Hill) district, and it is suggested that a test well should be sunk from the crest of one of the geological domes to a depth of 3,000 ft. if necessary.

A still lower oil horizon has been found at Abu Durba, Western Sinai, in Nubian sandstone (*Petroleum Research Bull. No.* 1, 1921, *Ministry of Finance, Egypt*). The Abu Durba range is an asymmetrical anticline in structure. A considerable area of coarse quartzose Nubian sandstone occurs here. Geologically it lies at the base of the Upper Cretaceous series, and is of Cenomanian (or Lower Chalk) age. It consists of a series of sedimentary rocks, usually ferruginous, with a basal bed of coarse quartz-conglomerate. A test bore-hole, put down near an outcrop of oil-rock, struck a little oil from 140 to 142 ft. in depth; and between 172 and 185 ft. the yield was 1 ton of petroleum in twenty-four hours. The oil is black and heavy (sp. gr. at 60° F., 0·973), and contains 8·8 per cent. of asphalt. Further particulars relating to this region, taken from the above-mentioned *Research Bulletin*, will be found in this BULLETIN (1921, **19**, 419).

There are no actual seepages of oil in Northern Sinai (*Petroleum Research Bull. No.* 10, 1921, *Ministry of Finance, Egypt*), and the most common oil indications are impregnations and discolorations of certain rocks, but no definite conclusions have been arrived at as to the origin of the oil that has caused these impregnations. The oil horizons in Northern Sinai may be divided into four geological districts: (1) the Miocene foreshore; (2) Eocene areas; (3) Cretaceous subdivisions, Chalk and Cenomanian; (4) Jurassic rocks.

Much prospecting does not seem advisable in district (1), but the information to be obtained from the well now being started here will be looked forward to with much interest from a geological point of view. The remaining districts deserve every attention and thorough investigation, and hold out prospects of success as a reward for the labour and expense of making a diligent search for oil. Structure (long anticlines on whose crests domes of considerable

size are situated) is in several instances very favourable. With regard to lithology, there are sandstones and limestones to play the part of reservoir rocks with many interbedded layers of impervious marls to serve as cap rocks. The following are regarded as the most favourable: El Minshara fold and Ras el Jaifa dome; the latter, being nearer Suez, is better situated from a transportation point of view. Many of the remaining areas present prospects only slightly inferior to the above. A few of these have been tentatively suggested for reservation, leaving still a large hunting ground for private enterprise.

Canada.—The occurrence of oil in the Mackenzie River Valley, North-West Territories, described in the *Monograph* (p. 34), have been subjected to more detailed examination, and summaries of papers dealing with the region have been published in this BULLETIN (1921, **19**, 103, 420).

According to E. M. Kindle and T. O. Bosworth (*Canada Geol. Survey, Summ. Rept. for* 1920, Pt. B., p. 37) there are, extending over a large area at Fort Norman in the North-West Territories, 1,000 ft. or more of highly bituminous limestones and shales from which an immense quantity of petroleum might have been generated; and, overlying these beds, there occur from 2,000 to 3,000 ft. of clay shales and sandstones, from which numerous seepages of oil arise. Moreover, the mass of petroliferous deposits is traversed by large, bold, anticlinal folds. The sum of the geological evidence, together with the result of the test well, indicates an extensive oil region in which a number of oil-fields may occur. As stated in *Min. Ind.* (1920, **29**, 508), a second well is being drilled on the shore of Great Slave Lake, about 500 miles S.E. of Fort Norman.

Australia.—Small seepages of oil have been found at Price's Creek, Kimberley district, Western Australia. T. Blatchford (*Mining Mag.*, Dec. 1921, p. 361) has examined the area. A shallow boring proves that the oil is contained in sandstone and thin limestone of Carboniferous age. Anticlinal structures extend throughout the whole of the area between Price's Creek and Mount Wynne, 100 miles to the W.N.W. At Mount Wynne there is an anticlinal arch upon which is situated a hot spring with a temperature of about 110° F., yielding continuous bubbles of gas.

Glance pitch has been found at Oake's Find, 200 miles N.E. of Price's Creek. According to Blatchford, there is every reason to believe that the pitch has come in the form of mineral oil from unexplored underlying beds, which

has, by a process of inspissation, left the pitch residual behind, filling the cavities in the rock through which it has migrated. A systematic survey is necessary to ascertain whether the oil still exists.

New Guinea.—P. H. M. Macintosh (*Chem. Eng. and Min. Rev.*, Nov. 5, 1921, p. 54) has found pronounced seepages of oil about two miles from the mouth of the Wapik River, Matapau, New Guinea. They occur in the river bed and banks for a distance of about 100 yards, and half a mile further up there are other seepages for 40 yards. The surface soils, consisting of sands and gravels, were heavily saturated with oil, and the source appeared to be at a point where the limestones are in contact with volcanic rocks. The natives have used this oil for many years to light fires, etc. The rock exposed in the river comprises beds of sand, gravel, clays and raised coralline limestone. Another seepage was found below the village of Asuli on a tributary of the Hallikamak River, which it joins at a point 6 miles from its mouth.

New Zealand.—In the Warwick River district, Murchison, South Island of New Zealand, several seepages of petroleum occur in certain beds of conglomerate, which appear to correspond with the Upper Conglomerate of the Waimangaroa Series (lower coal measures) of James Park. Oil is oozing from a bed of soft marine sandstone near the top of a saddle. The series of beds of conglomerate must be over 1,000 ft. thick. They contain, according to Sydney Fry (*Chem. Eng. and Min. Rev.*, Nov. 5, 1921, p. 52), small lenticular bodies of lignite. An examination of the local dips suggests a general anticlinal arrangement, and small faults are present which may have helped to seal up the petroliferous contents of the conglomerate. A sample of the crude petroleum proved to be of excellent quality.

Czecho-Slovakia.—A report on the possibilities of Czecho-Slovakia for oil production was issued in 1920 by the *Research Division, U.S. Bureau of Foreign and Domestic Commerce*, and from it the following information has been taken.

In Czecho-Slovakia petroleum is found in two regions adjoining the Carpathians, on the east in Slovakia and on the west in Moravia. In the latter province, traces of petroleum have been found in many places, particularly at Ratiskovice and at Bohuslavice.

The Gbely oil-field, in the county of Skalia, district

of Nitra, is the one in Slovakia which has been proved the most. A number of wells were sunk here during the war. At present drilling is confined to the Sarmatian (uppermost Miocene) strata. The wells are 200 ft. apart and average 835 ft. in depth. The oil is heavy, having a specific gravity of 0·930. One well has been drilled to a depth of 1,115 ft. and is being continued. Traces of oil were found at 650 ft.

At Ratiskovice, Moravia, it has been ascertained that lighter oils can be obtained at greater depths from Oligocene strata.

The production of oil at Gbely in 1918 and 1919 is estimated at 8,300 and 7,200 metric tons, respectively. The value of the Gbely wells has been estimated at about £500,000.

Italy.—According to the *Financier* (Feb. 16, 1922), six large petroliferous areas have been recently located in Italy: in the Valle di Pescara; at Lazio; in the Valle del Liri; and in Basilicata; similar areas have also been found in Sicily. In Basilicata positive results have been obtained near Monte Vulture, Commune di Rapola. The Government of Italy during the war appointed a National Fuels Committee, which spent 30,000,000 lire in development work. Researches and borings are being continued.

At Ripi, near Frosinone Lazio, six wells have proved the presence of petroleum, but two are over 3,000 ft. deep.

Russia.—The total output of oil for the first six months of 1921 from all the oil-fields of European Russia, was 1,976,000 metric tons as compared with 2,000,000 and 4,641,000 tons for the same periods of 1920 and 1915 respectively.

The acute shortage of labour and the heavy self-consumption of the pumping and compressor plants, which use about 65 per cent. of their own output, impelled the Soviet authorities to push forward the work of electrifying the wells. An electrically-driven oil-well plant requires one-half the personnel of a steam plant, and one-fourth of that of a gas-driven plant. In 1920, only four wells were electrified in the Baku region, in addition to the existing electrically-driven plants, but during the nine months of 1921, 145 electric motor compressor and pumping plants were installed, with aggregate capacity of 10,592 H.P. and 12,000 metres of underground cable were laid. The results are noteworthy. The output of the electrified wells in 1921 increased from 87,790 tons in

January to 115,354 in September (*U.S. Comm. Rept.*, 2, Jan. 9, 1922, p. 89).

Yugo-Slavia.—The chief occurrences of petroleum in Croatia are found in two lines: one (the northern) starts from the Mur Island parallel with the river Drave, and the other (the southern) from Ivanic-Klostar, parallel with the river Save. Oil has been found to occur in several places along both lines.

Northern Oil Line.—At Paklencia, oil was long ago obtained from shallow holes and wells. Asphalt is now being produced here. Green oil was found in one of the bore-holes put down recently, but the work was stopped owing to technical difficulties. At Selnica, some borings made in 1905, the deepest of which is 1,000 ft., produced 3,000 tons of oil. At Ludbreg oil and gas indications were found at a depth of 1,920 ft. At Veliki-Poganec, oil indications have been found at various depths. The oil horizon appears to go with the deepest sections of Pliocene clays and the highest sections of Miocene. At Ribnjak, two borings and one hole gave 50 barrels of oil. A greenish-black oil obtained in a 33-ft. test hole had a specific gravity of 0·845. At Pitamaca, oil was found at several depths.

Southern Oil Line.—At Mikleuska, in the valley of the brook Paklencia, are many tar and oil sources. The oil horizon appears to be a light grey plastic clay of the Pontine formation. The oil (tar oil) was taken out by means of holes up to 200 ft. in depth. The clay was entirely impregnated with it. In 1905 a bore-hole was put down to a depth of 2,660 ft., tar was found at a depth of 230 ft., and gas at 32, 1,475, 1,640 and 1,935 ft. The formation consists of clay, chalk, slate and sandstone. At 1,640 ft., the clay was salty and the oil came out in the form of tar mixed with water. In some places here the tar is changed to asphalt. The specific gravity of the tar was 0·936, and an analysis gave the following percentages: carbon, 82·48; hydrogen, 11·42; oxygen, 6·10. At Voloder, there is a thick vein of bituminous stone, soaked with oil. At Petrovoselo-Staro, tar-oil is found in many places. The formation, which is white clay, impregnated with oil, belongs to the Tertiary. In the middle of the last century, from 70 to 80 tons of oil were taken out of numerous holes here. At Lipik, a bore-hole, put down by the Hungarian Government (1914-18), struck gas in large quantities at depths of 1,150 and 1,283 ft., and oil-bearing sands, from 13 to 16 ft. in thickness, below the second gas horizon. The oil is thick and tarry, and is clarified in large tanks. The well was

successfully closed. Gas has also been found at Precec and Lipovec.

The Yugo-Slavia oil-fields seem to be at the lower end of a curve formed on the north by the Galician—now Polish—oil-fields, and on the east by the Rumanian oil-fields, both of which regions are known to be very rich. The above information on petroleum deposits in Yugo-Slavia has been taken from *The Oil Encyclopedia*, 1922, p. 261 (Marcel Mitzakis), and from the *Report on the Geology and Mineral Resources of the Serb-Croat-Slovene State* by D. A. Wray (Dept. of Overseas Trade, 1921). Further information has been given in this BULLETIN (1921, **19**, 422).

Dutch Borneo.—A paper by James Kewley (*Inst. Petr. Technol.*, July 1921, p. 209) on "The Crude Oils of Borneo" deals with the three distinct types of crude oil found in the Koeti field, and their possible origin. An abstract of the paper has appeared in this BULLETIN (1921, **19**, 103).

Sumatra.—According to Arthur H. Redfield (*Eng. and Min. Journ.*, Dec. 10, 1921, pp. 939–943), the Middle Palembang stage (Lower Pliocene) contains the principal oil horizons of the Residency of Palembang, Sumatra. A typical development of this stage is found in the Kampong Minjak and Minjak Itam oil-fields, east of Moeara Enim, in Palembang. Its lowest member consists of lignite measures about 130 ft. thick. The "lower clays" overlying the lignites are made up of about 295 ft. of sandy and pure shaly clays, and are overlaid by shaly sandstones, 410 ft. thick. The "upper lignite measures," which form the highest measures of the stage, are about 410 ft. in thickness.

The oils from the Palembang fields have an asphalt base, and are dark brown, red-brown or greenish-grey in colour, and rich in gasoline and kerosene. The specific gravities of oils from the Moeara Enim range vary from 0·835 to 0·875 at 15° C. The average kerosene content varies from 30 to 40 per cent.

There are good prospects of obtaining petroleum in commercial quantities in central Djambi, N.W. of Palembang, where numerous seepages of oil occur. The anticlines and synclines of the Palembang peneplain are continued in Djambi, but petroleum will probably be found in a lower horizon, for, in Djambi, the Middle Palembang stage shows less thickness, and only contains a few interbedded and comparatively thin lignite seams. However, the Lower Palembang stage, which comprises the productive

oil horizons of Atjeh, is well represented in Djambi, and contains a proper succession of porous and impervious beds, suitable for the accumulation of commercial deposits of petroleum. It is significant that by far the greater majority of the oil seeps, gas emanations and salt springs (*soebans*) in Djambi occur in outcrops of the Lower Palembang beds. A few issue from the Telisa beds (Lower Miocene), and few or none from the Middle Palembang.

Philippine Islands.—The presence of petroleum in the Bondoc Peninsula has been mentioned in the *Monograph* (p. 63). According to Warren D. Smith ("Petroleum and Residual Bitumens," *The Mineral Resources of the Philippine Islands for the Years* 1919 *and* 1920, issued by the Division of Mines, Bureau of Science, Manila, 1922), the petroleum is associated with an extensive series of beds of sandstone and shale (Vigo shale) of middle Miocene age, and similar in character to the oil-bearing rocks of productive fields, notably those of Japan. The structure includes a number of anticlinal folds, and the conditions along some of these anticlines are considered favourable for the accumulation and retention of petroleum.

"Rock asphalt" was discovered in the island of Leyte in 1912. The deposit, which is apparently of considerable size, is in reality a paraffin residuum, corresponding most nearly to ozokerite, which impregnates porous limestone and sandstone. It occurs in the Malumbang series (Tertiary), and is being developed. The Canguinsa series (also Tertiary) contains solid bitumens in lenses and pockets and in fissures, and solid bitumen mixed with bitumen-impregnated clay-tuff fragments; also viscous and semi-liquid bitumen forming the cement of limestone-breccias, or filling the centres of hollow, cylindrical concretions in clay-tuff. Warren D. Smith is of opinion that the Canguinsa sandstone, a buff-coloured, very porous and somewhat tuffaceous formation above the Vigo, may prove to be the reservoir for holding the oil.

The Pidatan field, Mindanao Island, was investigated by Smith and others in 1921. The Tertiary sediments in the vicinity of the seep are badly faulted, and although there was nothing to encourage drilling in that particular region, it seemed justifiable to consider further geological exploration in the surrounding territory in Cotabato Province. Two seeps are reported on Mindoro Island, and, on Panay, Tertiary shales yielding gas are found on the eastern flanks of the main range of mountains and are generally monoclinal. There is at least one well-defined local (Maasin) anticline, which might be a favourable location

for a test well. However, some artesian wells drilled to a depth of 1,728 ft. in that region have shown only small amounts of natural gas, apparently marsh gas, and salt water. A petroleum seep is reported on Siasi Island, in the Sulu group.

Mexico.—L. G. Huntley and Stirling Huntley (*Bull.* 177, *Am. Inst. Min. and Met. Eng.*, 1921, p. 27) estimate the total production of five of the Gulf zone or " Tampico embayment area " pools in Mexico at 452 million barrels of oil, and the present reserves at 250 million barrels. This estimate does not include the Panuco River pools which lie along the crest of a broadly plunging arch, and produce both from the San Felipe and the Tamasopa formations. It is estimated that after all the pools at the south end of the zone have been flooded by salt water, there will still be a production in the Mexican fields of 250,000 barrels per day at the end of 1,000 days from July 1, 1921, on the assumption that the new drilling in the Panuco River field increases production. Meanwhile, it can be assumed that prospecting will have probably extended the producing area in the Panuco River district, and those to the south and west of Alamo. In the region between the Tecolutla and Cazones Rivers, south of Alamo, a relatively sharp fold is found which brings the Tamasopa limestone within drilling distance of the surface. This fold apparently constitutes the first barrier fold east of the coast in this region, and, as it contains both seepages and recent intrusives along its crest, should constitute a good reservoir for oil.

In this region there are good indications that there will be found pools of relatively light oil in sand and limestone formations above the Tamasopa, as well as in the latter formation itself. In the case of the probable pools yielding from reservoirs above the Tamasopa, these will undoubtedly have smaller wells producing over a longer period of time in comparison with the large Tamasopa wells to the north. An article dealing with " The Isthmian Oil-fields of Mexico," by Arthur H. Redfield (*Eng. and Min. Journ.*, March 19, 1921, p. 501), describes the Tehuantepec and Tabasco-Chiapas oil-fields in the Minatitlan zone. An abstract of this paper has already appeared in this BULLETIN (1921, **19**, 104).

According to Roy H. Flamm (*U.S. Comm. Rept.*, 8, Oct. 24, 1921, p. 464), the chief characteristics of Mexican oil are as follows : The wells flow continuously under their own pressure ; there is no " oil sand " in the sense of the United States use of the term, except perhaps in the south-

ern region; the temperature of the oil produced is high, from 32° to 83° C.; it is of high gravity, and therefore of low gasoline content, averaging from 5 to 16 per cent. According to one authority, it averages 9 per cent. of naphtha; 10 per cent. of illuminating oil; 50 to 75 per cent. of fuel oil; the remainder consisting of lubricants, paraffin, asphalt, etc. In 1920, the average daily production of 300 wells amounted to 1,800 barrels per well.

Colombia.—The oil-bearing formations of Colombia, according to Elfred Beck (*Econ. Geol.*, 1921, **16**, 457), are Upper and Lower Cretaceous and Lower Tertiary. The oil usually occurs in sandstones and sometimes in porous limestone. The most promising formations are sandstone members of Tofeme formation, which is capped by thick impervious Bombo shales. The Huertas limestone group (alternating sandstones and porous limestone) is also promising.

In the Puerto Colombia district, near Tubara (Caribbean zone), several wells have been sunk from 700 to 3,018 ft. in depth. One well has yielded from 7 to 8 barrels of oil daily. A rotary drill is being used. At Turbaco, 11½ miles S.E. of Cartagena, in the same zone, small quantities of oil and gas have been encountered at various depths. One hole has been drilled to 2,200 ft. In the Sinu district, near Lorica and Monteria, in the same zone, one well at 2,000 ft. gave a small quantity of oil and gas.

In the Barranca-Bermeja district, Magdalena-Santander zone, there is a well-defined anticline and oil has been found in Cretaceous rocks at depths ranging from 1,500 to 2,000 ft. In 1918 one well produced 5,000 barrels daily. The oil is light green in colour, with a specific gravity of 42°–54° B., and yielded the following percentages: gasoline, 1·00; kerosene, 41·00; lubricating oil, 53·00; non-volatile residues, 5·00; sulphur, 0·55. Oil has also been found in the Pamplona district in the same zone where the geological structure is favourable, but the wells at present are shallow and the yield is small.

Uruguay.—Investigations for oil have been carried out in Uruguay by the Instituto de Geologia y Perforaciones. Indications of oil have been found, notably in the north and north-east, where oil-bearing or bituminous strata of Southern Brazil enter that region. Borings have been made near the city of Melo to a depth of 1,640 ft. At 500 ft. flows of water were encountered, having a strong odour and taste of petroleum (*U.S. Comm. Repts.*, No. 305, 1920, p. 1343).

Venezuela.—British Controlled Oil-fields, Ltd., have for the last few years been developing their Buchivacoa concession in Venezuela. According to D. A. Sutherland (*Petr. Times*, Feb. 18, 1922, p. 213), seven wells have been completed up to the present; strong gas pressures and oil were struck in all, the wells flowing intermittently. The exploration well, which yielded oil, flowed for nearly two years. The crude oil is of exceptionally high quality, and is superior to Mexican and average Persian crude oil. The question of transport to seaboard presents no difficulties. In the region are recurring domes over a distance of more than fifty miles in length. The strata containing petroleum thicken down the southern flank of a well-marked anticline. The formation of the whole oil-field is so remarkably regular that the calculation of the depths at which wells will be brought into production can be gauged to within a few feet.

NOTICES OF RECENT LITERATURE

HANDBOOK OF THE STATE OF BRITISH NORTH BORNEO. Compiled from Reports of the Governor and Staff. Pp. 112, 8vo, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: British North Borneo (Chartered) Company, 1921.)

This interesting publication is the first official Handbook for British North Borneo which has been issued since 1890. It begins with a concise account of the history of the Territory, and its relation to Borneo as a whole, up to the constitution in 1888 of the State of North Borneo as a British Protectorate, whilst later sections of the book deal, among other matters, with the climate and hygienic conditions of the country; its mineral and vegetable resources, ethnology and topography; agricultural enterprise, and openings for capitalists and settlers.

The Protectorate has taken its share in the modern plantation rubber industry, and the exports of rubber rose from about 5,000 lb. in 1907 to over 8,800,000 lb. in 1919.

The indigenous economic resources of the State are dealt with in chapters on Natural and Forest Products, Timber and Minerals. In regard to timber the Department of Forestry estimates that within twenty miles of the coast there are more than two million acres of forest of commercial interest which is believed to be capable of yielding over two thousand cubic feet to the acre.

Several seams of coal have been found in the Protectorate, but the only coal at present being worked is that on the Silimpopon River, at a point situated in the midst of dense forest, the coal being conveyed by railway to a loading station where the water is deep enough for barges. The available supply of this coal, which is of good steam-raising quality and has been used to some extent by the Japanese Navy, is estimated at eight million tons.

Indications of petroleum have been found in many parts of the State and some prospecting has been done, resulting in certain cases in the discovery of oil of good quality, but it would appear that no quantity sufficient to justify extensive borings has yet been located.

The geography and ethnology of the country are described in a most instructive way. It is stated that the native tribes " on the whole show every symptom of thriving and increasing, and there does not appear to be any fear of their disappearing as so many races have done when brought into contact with Europeans."

This new handbook, excellently compiled and printed, and containing several photographs illustrative of various industries of the Protectorate, forms a useful source of information for any reader interested in British North Borneo.

Recent Colonisation in Chile. By Mark Jefferson. Pp. 52, 8vo, 7½ × 5. Publication No. 6 of the American Geographical Society's " Research Series." (New York: Oxford University Press, American Branch, 1921.)

This handy booklet, well printed and containing a number of photographs, maps and diagrams, aims chiefly at describing the attempts at organised colonisation made in Chile in modern times, both at the instance of the Government and otherwise. Its actual scope is, however, wider than this, covering as it does a short survey of the social, economic and ethnological conditions of the Republic, together with useful information on its history, natural resources and climate.

The general conclusion arrived at in regard to colonisation is that not much effective enterprise is possible in this direction; Chile, as compared with North America or the Argentine, " is not in the immigration class at all," owing to the small extent of the areas still available for settlement. Agriculture flourishes in the well-developed sunny region of central (or " Creole ") Chile, but " almost two-thirds of the national domain is utterly hopeless " from this point of view, including not only the sterile nitrate lands of the north and the vast solitudes of the

higher Andes, but also the "mist-wrapped, rain-swept forests" of the southern archipelagos.

An interesting account is given of the various ways in which foreign colonisation has been attempted, even to the extent of dispossessing Chilean tenants and squatters in the Frontera (the former Indian Reservation, where the aboriginal Araucanians still maintain a semi-independent life in the forests). The author shows that the influence of German immigration has been much exaggerated, and that the colonists represent a number of nationalities, including Spanish, Italian, French and English. All the foreign immigrants together form only a small part of the population, and the author considers that any further attempts at organised agricultural development should consist in helping more of the labouring class of Chileans to acquire land, instead of bringing in outsiders and driving Chileans to seek work elsewhere.

Useful information is given regarding the products of the country, both wild and cultivated. The yields per hectare of wheat, barley, oats, potatoes and maize compare very favourably with those obtained in agricultural countries such as the Argentine, the United States and France, though as regards total quantity the production cannot increase to any great extent since the area available for crops is relatively so small. The Chileans grow many useful fruits, including grapes, oranges and peaches, whilst as regards animals it is reckoned that on the grass lands of Magellanes Province in the extreme south, which are very suitable for sheep raising, there were in 1916 some two million sheep, against half a million in 1891 and only 40,000 in 1885.

The rainy forests of the Frontera and the region immediately to the southward consist to a great extent of trees which are regarded as commercially useless, and large quantities of timber are imported into central Chile from North America. The domestic production was estimated in 1913 at only 45 per cent. of the country's requirements. Of this home supply, moreover, a considerable portion is derived from an exotic tree, the European poplar, which flourishes in Chile and is much used as a source of timber for constructional work.

A well-written treatise of this kind, catering both for the economist and the general reader, forms an admirable publication, and further booklets on the same lines dealing with other countries would be welcome.

BRAZILIAN COTTON: being the Report of the Journey of the International Cotton Mission through the Cotton

States of São Paulo, Minas Geraes, Bahia, Alagoas, Sergipe, Pernambuco, Parahyba, Rio Grande do Norte. By Arno S. Pearse, General Secretary of the International Federation of Master Cotton Spinners' and Manufacturers' Associations. Pp. 231, 8vo, $9\frac{1}{2} \times 6$. (Manchester: International Federation of Master Cotton Spinners' and Manufacturers' Associations, 1922.) Price 21s.

This work constitutes the report of a tour through the principal cotton-growing States of Brazil during March–September, 1921, by Mr. Arno Pearse, and Messrs. Max Syz and Fritz Jenny of Switzerland, who were accompanied by several officials of the Brazilian Government. The report is prefaced by a few short chapters dealing with the geography, history and general economics of Brazil. An account is given of the local cotton spinning and weaving industry, together with a general survey of the present conditions of cotton cultivation in the country. In subsequent chapters, particulars are furnished of the position and prospects of the cotton industry in each of the States mentioned in the title, whilst the final chapter refers briefly to the principal economic products exported from Brazil and the chief Brazilian industries. An appendix to the report contains a list of Brazilian cotton mills with full particulars relating to the number of spindles, looms, kinds of goods produced, capital, etc., and an address given by Mr. Pearse at Rio de Janeiro in August 1921 before the Sociedade Nacional de Agricultura.

As a result of their observations, the members of the mission have come to the conclusion that the area suitable for cotton growing in Brazil is larger than that of the United States of America, and that the conditions of climate and soil are probably more favourable to the industry than those of any other part of the world. At the present time, however, the production of cotton in Brazil does not exceed 700,000 bales of 500 lb. each, as compared with from 12 to 16 million bales produced in the United States.

There are certain factors which have prevented any great extension of the industry, of which the chief are the scarcity of labour, which is especially noticeable in the north of the country, and the unsatisfactory methods which are practised in the cultivation and handling of the crop. A serious defect is the lack of uniformity of the cotton due to the growth of several different varieties in one and the same field. This results in the production of a crop containing fibres of various lengths and various degrees of fineness. It is therefore recommended that the Government should establish seed farms on which

selection work should be undertaken with a view to providing for distribution to growers pure seed of one variety only for each district.

It is also reported that the ginning is effected in a most unsatisfactory manner and that serious results are caused by the sale of mixed seed by the owners of ginning factories, and the opinion is expressed that the establishment of factories with roller gins would materially contribute towards the prevention of deterioration of the fibre and would be to the mutual advantage of grower, ginner and spinner.

The work has been written in an interesting manner, and contains a large number of excellent illustrations and maps.

PRODUITS OLÉAGINEUX ET HUILES VÉGÉTALES. Etude statistique sur leur production et leur mouvement commercial. Pp. xxxii + 443, $9\frac{1}{2} \times 6\frac{3}{4}$. (Rome: Imprimerie de l'Institut International d'Agriculture, 1921.) Price 20 francs.

The contents of this book consist of statistical tables giving the areas and yields of the world's crops of the chief oil-bearing plants, the production of vegetable oils and the imports and exports of oleaginous products. The book is divided into two parts. The first, arranged under countries, deals with the area and production of oil seeds, etc., for the last fifty or sixty years in the different countries, together with import and export returns for the decade 1910–19. The other part is arranged under the headings of the different oil seeds, etc., and also gives import and export returns for the same period.

LES PRINCIPAUX ENNEMIS DU CACAOYER AUX ILES DE SAN-THOMÉ, ET DE PRINCIPE. Rapport sur une Mission d'Etude Agricole et Phytopathologique. By Henri C. Navel. Pp. 127; 53 photographic reproductions, 2 maps, and 4 coloured plates; 8vo, $10 \times 6\frac{1}{2}$. (Paris: Emile Larose, 1921.)

The Direction of the Society of Emigration of San Thomé and Principe, alarmed by the damage which was being caused to the plantations of those countries by the various enemies of the cocoa tree, despatched a Mission in 1919 to study the different affections and to suggest the best means of combating them. With this end in view, M. Henri C. Navel visited nearly all the plantations of both islands, and the material collected was determined at the National Museum of Natural History at Paris.

M. Navel divides the principal enemies of cocoa into three groups: (1) Maladies which are not due to parasitic attacks, but are caused by wounds, the action of the soil and climatic conditions, the want of hygiene in plantations, the suppression of shade trees, bad procedure in planting, etc.; (2) the parasitic insect enemies which attack with more virulence trees already under the influence of the maladies in the first group; and (3) the cryptogamic parasitic enemies, of which a certain number attack plants in a good state of vegetation, whilst others are induced by the presence of the influences mentioned under the first two groups. The author points out the effect of erroneous cultivation, due to the suppression of shade in the drier districts, where the process of "piquage," a destruction of natural shade by ringing the forest trees, is commonly practised, and compares it with the conditions of growing cocoa without shade in the elevated regions, where rain falls more frequently and where the depressions in the soil are such that shelter and shade are naturally provided without the necessity of extraneous tree growth.

With regard to insect pests, a species of thrips (*Heliothrips rubrocinctus*, Giard) is said to cause the greatest damage. This insect was introduced into the islands from Brazil and now occurs everywhere, being most prevalent in those parts where the diminution of shade trees is taking place. Various beetle and moth larvæ are referred to, which attack the trunks by boring, and white ants are also mentioned as enemies. A beetle (*Nistora theobromæ*, Labois) and a Helopeltis, identical with that found on the mainland of West Africa, attack the fruit and mark it with their puncturings, which permit of infestation by fungoid pests, leading to the destruction of the whole fruit. The author gives an illustration of *Sahlbergella singularis*, Hagl., which he records from the Belgian Congo and which with *S. theobromæ*, Distant, is perhaps the worst pest on cocoa in the Gold Coast. Neither of these parasites appears to have been met with at San Thomé or Principe. Several fungoid pests are dealt with, including a mildew (*Phytophthora Faberi*, Maubl.) which is very injurious to the fruit.

The volume should be of great utility to planters and others in the West African cocoa plantations.

Power Alcohol: Its Production and Utilisation. By G. W. Monier-Williams, O.B.E., M.C., M.A., Ph.D. Pp. xii + 323, 8vo, $8\frac{3}{4} \times 5\frac{1}{2}$. (London: Henry Frowde and Hodder & Stoughton, 1922.) Price 21s.

With the ever-increasing use of internal combustion engines for motor and other purposes, the problem of fuel supply becomes yearly of more pressing importance.

Petroleum is still the main source of motor spirit, but the world's supply of petroleum is very problematical, the estimates of the quantities available varying considerably. Coal constitutes another source of supply of motor fuel, and its possibilities in this direction when submitted to low-temperature carbonisation under various conditions are being further investigated by the Fuel Research Board, but it is unlikely that it will prove possible to manufacture benzole from coal in quantities which would represent annually more than a small fraction of the demand for motor spirit.

Under the circumstances it becomes necessary to take stock of every possible source of motor fuel, and the question of supplies of alcohol for power purposes has therefore become of considerable technical and economic importance. It has been found that alcohol is well suited for use as a fuel for internal combustion engines ; and it has the advantage that it can be produced from vegetable sources which are continually renewable at a rate only limited by the area available for their production, whereas both coal and petroleum are parts of the world's capital resources.

Dr. Monier-Williams's book deals with the various aspects—chemical, physical, biological, engineering and economic—of the alcohol fuel question in a manner that shows an extensive knowledge of the subject combined with good judgment in utilising available published information.

The introductory chapter is a critical discussion of the "Motor Fuel Question" which leads the author to the conclusion that "the balance of evidence appears to favour the view that before many years have elapsed the supply of petrol will be permanently unequal to the demand, and that power alcohol, considered from the standpoint of a supplementary and not necessarily a competitive fuel, has an undoubted future before it, provided that the industry is organised and developed on sound lines."

The second chapter, on "The Plant as a Source of Alcohol," gives an up-to-date account of biochemical work having a bearing on the main subject. Here, as elsewhere in the book, the necessary conciseness of the text is compensated by a very full list of references to original sources of information.

The technology of alcohol production from starchy and saccharine materials is dealt with, and an excellent

account is given of the "amylo" process for the saccharification of starchy materials by means of diastase-producing moulds, which has recently been developed on the Continent.

The more important possible raw materials for the production of power alcohol are compared with respect to their yields and availabilities, and several economic factors bearing on the power alcohol question are discussed. An account is given of the various processes for manufacturing alcohol from cellulose materials. The chapter on "Synthetic Alcohol" is necessarily such as to present some difficulties to readers who are not chemists, but both chemists and others will find food for thought in the concluding paragraphs headed "Economic Considerations."

Excise supervision and denaturation in this country and others are next dealt with, and there then follows a useful "Outline of the Principles of the Internal Combustion Engine."

Other subjects dealt with include the chemical and physical properties of alcohol from the motor-fuel standpoint, the results of engine tests carried out by numerous investigators with alcohol in comparison with hydrocarbon fuels, and the value as motor fuels of various mixtures containing alcohol.

Land Drainage. By W. L. Powers, M.S., and T. A. H. Teeter, B.S. Pp. ix + 270, 8vo, $8\frac{1}{2} \times 5\frac{1}{2}$. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1922.) Price 13*s.* 6*d.*

This book, which deals with the subject of drainage from an agricultural standpoint, may be regarded as a useful textbook. Apart from the benefits of reclaiming marsh lands and shallow lake beds for agricultural purposes, the importance of efficient drainage of land already under cultivation can scarcely be exaggerated. Striking examples of the value of land reclaimed by drainage methods are afforded by the Lincolnshire and Cambridgeshire fen areas in England and by large areas in Holland. These lands are characterised by great fertility, and notwithstanding the cost of maintenance of the necessary drainage systems, their reclamation has proved in every way an economic success. As the authors point out, the reclamation of the bed of the Zuyder Zee, a large engineering feat, is being seriously considered and has already received the sanction of the Dutch Government. A competent authority is quoted to the effect that there are 150 million acres of imperfectly drained cultivated

land in the United States. If efficient drainage methods were applied to this vast area, an enormously increased crop yield might reasonably be expected.

The authors describe the various types of agricultural drains, including open channel drains, and the various materials used for covered drains, e.g. wood, cement-tile and clay-tile, and show under what circumstances each type is to be preferred. The breaking up of " hard pan," an impervious layer of subsoil, by explosives is mentioned, and also the need for the underground drainage of much land that is irrigated. The latter part of the book deals with the drainage of districts, special drainage problems, drainage surveying and laboratory exercises. Generally the book appears to justify the claim of its authors that it is " a textbook for students of agricultural engineering, a reference book for practical farmers and an aid to owners of wet, overflowed, marsh, swamp or alkaline land who desire to improve their holdings."

Basic Slags and Rock Phosphates. By G. Scott Robertson, D.Sc., F.I.C. Pp. xvi + 120, 8vo, $9\frac{1}{2} \times 6\frac{1}{2}$. (London: Cambridge University Press, 1922.) Price 14*s*. net.

Basic slag was for many years obtained as a by-product solely from the manufacture of steel by the basic Bessemer process. At first the supply exceeded the demand, but during the past few years it has become evident that the supply of slag from this source will soon prove inadequate to meet the demands of agriculture. The decrease in the quantity of basic Bessemer slag is due to the Bessemer process being partly displaced by the basic open-hearth process, in which the slag produced is of a somewhat different type and less rich in phosphate.

The present volume is an exhaustive record of field trials carried out during 1915–20, in order to determine the relative values of the slags and raw mineral phosphates for manurial purposes. Experiments were carried out on grass land at several centres in Essex on typical boulder clay, London clay and chalk soils. The phosphatic materials, initial dressings of which were applied to the plots at the rate of 200 lb. of phosphoric acid (P_2O_5) per acre, comprised basic Bessemer slag, basic open-hearth slag (with and without fluorspar), raw mineral phosphates from Florida, Tunis, Algeria, Gafsa and Egypt, Cambridge coprolites and ferruginous Cleveland phosphate. The effect of the manures was measured by the increase in the weight and improvement in quality of the hay crop.

The results indicated that over a period of years

raw mineral phosphates may be expected to give as good results on pasture land on the boulder or London clay as those obtained with high-grade basic Bessemer slag, but they require a higher rainfall to give their maximum result.

The basic open-hearth fluorspar slags proved somewhat uncertain in action, but as a rule those containing a small proportion of their phosphate in a form readily soluble in citric acid were less effective than raw mineral phosphate.

The author also discusses the effect of the phosphates on the moisture content, temperature and accumulation of nitrate in the soil, and also their influence on soil bacteria. The concluding chapters deal with factors limiting the yield of hay and with the action of basic slag on soil acidity.

The book will prove of great utility and interest to all concerned in the improvement of pasture land, especially in those localities where raw mineral phosphates are readily available and manufactured phosphates costly to obtain.

THE RIFT VALLEYS AND GEOLOGY OF EAST AFRICA. By J. W. Gregory, D.Sc., F.R.S., Professor of Geology in the University of Glasgow. Pp. 479, 8vo, $8\frac{3}{4} \times 5\frac{1}{2}$. (London: Seeley, Service & Co., Ltd., 1921.) Price 32s.

This work by the distinguished British geologist, who proposed the name "Rift Valley" for a valley occupying a relatively narrow space due to subsidence between parallel fractures, is mainly geological. In it the Great Rift Valley is traced from North Palestine, through the valley of the Jordan and the Dead Sea (1,293 ft. below sea-level) and down the parallel shores of the Red Sea. It is shown that this trough-like basin is continued southward through Eastern Africa in long fiord-like lakes, lying in steep, parallel-walled valleys, which in form resemble fiord valleys. Its geological history is mainly dependent on the volcanic rocks, owing to an absence of fossiliferous deposits, and hence the views as to the age of the Rift Valley vary. Suess regarded the valley as having been formed by earth movements confined to the two latest geological periods, but the author concludes that the Rift Valley and its associated volcanic eruptions had, in British East Africa, a long and broken history from the Upper Cretaceous down to the Upper Pleistocene. The evidence for this conclusion is given in Chapter XVI. There is an excellent geological description of the volcanic Mount Kenya, the central peak of which the author found to consist of a plug of igneous rock (nepheline-syenite)

which closed the pipe of the old volcano. He also discovered five glaciers on the S.W. side of the mountain in 1893, and, later, other discoverers found a series of glaciers on the northern face, while five smaller glaciers lie in circular hollows (*corries*) on the peak itself. The author found evidence of extensive moraines in the upper forests of Kenya, and there is clear evidence that ice once extended on Kenya about 5,000 ft. below its present limit.

The principal part of the work is devoted to British East Africa, now known as Kenya Colony, but there are chapters containing geological descriptions of Uganda and the Victoria Nyanza, the western branch of the Great Rift Valley, and of German East Africa (now Tanganyika Territory) and Lake Nyasa, forming the southern end of the Rift Valley. There are also chapters on Madagascar, Somaliland and Abyssinia. One chapter is devoted to the mineral resources of East Africa. Diatomite is abundant along the Rift Valley, and it is mentioned that experiments at the Imperial Institute have proved that it can be used locally for the manufacture of light tiles (cf. this BULLETIN, 1921, **19**, 306). Low-grade iron ores occur, and seams of bauxite are likely to be found in the intervolcanic beds. Pegmatite, with " books " of mica, occurs at Kenzi, Kenya Colony, and has been mined by open-cut methods. Graphite and ores of manganese are also known, and gold, silver-bearing galena, and antimony ores have been reported. There are also indications of coal. Trona (hydrous sesquicarbonate of soda) is the only mineral which has been extensively mined in British East Africa. It lies on the floor of Lake Magadi in a deep depression, and the author regards the deposit as having a deep-seated origin. There are interesting chapters on prehistoric man, on the caves, water-supply and wells, and on the soils of Kenya Colony. It is pointed out that investigations on the last were initiated by analyses at the Imperial Institute (cf. this BULLETIN, 1914, **12**, 515).

There are supplements to the book by various authors, including a description of igneous rocks by Agnes T. Neilson, as well as a full bibliography.

GENERAL ECONOMIC GEOLOGY: A Textbook. By William Harvey Emmons, Ph.D. Pp. 516, 8vo, $9\frac{1}{2} \times 6$. (New York and London: McGraw-Hill Book Company, Inc., 1922.) Price 20*s*.

This book, which constitutes an excellent introduction to the geological study of mineral deposits, has been specially prepared for students in colleges and technical schools, and although, naturally, the majority of the de-

posits described occur in the United States, the work should prove of great use to British students, and indeed to anyone interested in the occurrence of mineral deposits.

The first two chapters are general. Emmons's classification of primary deposits is given on page 5, and, although by no means ideal, it is more satisfactory than some other classifications that have appeared in recent years, in that the importance of temperature, pressure and depth from surface in the formation of mineral deposits is taken into account, and the pneumatolytic theory is not unduly emphasised. The term protore, given in a series of definitions, as signifying low-grade metalliferous material, from which valuable ore may be formed by superficial alteration and enrichment, has been used for some years now by American geologists, and deserves to become general. "Mother of coal" is described as material generally supposed to represent burnt wood or charcoal buried in the bed at the time of its formation. This seems to refer to the forest-fires theory of its origin, which has been suggested from time to time. Mother of coal or fusain, as it is now generally called, was shown, however, by Dawson in 1846 to be a modification of coal due to the more rapid and complete destruction of the plant-substance than took place with the rest of the material, such destruction being brought about, not by forest-fires, but by exposure to the air at or near the surface of coal swamps. Recent chemical and microscopical research seems to point to this view being the correct one.

There is an excellent summarised account of the coal-fields of the United States, and there are brief descriptions of those of Canada, Newfoundland and Mexico. One chapter is devoted to petroleum and natural gas, and another describes the oil-fields, oil-shales and asphalts of the United States and other countries. There are also chapters on the origin and classification, and on the deformation and enrichment, of mineral deposits; on the structural features of openings in rocks and epigenetic mineral deposits; on metasomatic processes and mineral associations, and on metallogenic provinces. The last twelve chapters are descriptive of mineral deposits, seven of them being devoted to non-metals and the rest to metals. This portion of the work should prove of great use to the student of economic geology, as a number of important deposits are illustrated and concisely described, and there are numerous references to original papers, etc., in the text.

Handbook for Field Geologists. By C. W. Hayes. Third edition, revised and re-arranged by S. Paige. Pp. xi

+ 166, 8vo, 7 × 4½. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1921.) Price 13*s*. 6*d*.

The new edition of this work follows in the main the previous issue. Methods of geological work with the plane-table have been revised and certain recently developed tables for useful calculation in stratigraphy have been added. A noteworthy new feature is an appendix by Dr. E. S. Larsen giving the chief characters of 125 commonly occurring minerals. Useful hints on survey organisation, equipment, preliminary observations, estimates of distances, horizontal, angular and vertical measurements are given as well as illustrated descriptions of methods for ascertaining the thickness of beds, the depth away from their outcrops, the determination of faults and the form of outcrops.

A valuable feature of the book are the schedules in Part II, of which there are fourteen prepared with a view to detailing the essential points in the examination of different types of geological formations. These schedules are accompanied by brief but clear explanatory notes, which should be of considerable assistance.

The book contains a mass of concisely stated information of value to geologists.

Mineral Land Surveying. By James Underhill, Ph.D., United States Mineral Surveyor for Colorado. Third edition. Pp. viii + 237, 8vo, 7¾ × 5½. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1922.) Price 17*s*. 6*d*.

This work is written with special reference to conditions and official methods for the survey of mineral lands in the United States. The opening chapter on the use of direct solar observations for obtaining the bearing of a given line is clearly expressed, and for students and those who wish to add a knowledge of the solar method to their current practice the descriptions given of the method and of the solar attachments will be welcome.

A chapter on measurements deals chiefly with traversing, and adds nothing useful to what has been published often before. The remainder of the book consists mainly of information which should be of value principally to mining companies and others interested in prospecting and mining operations in the United States.

Surveying for Settlers. A simplified Handbook for the use of Pioneers, Farmers, Planters and Others

Settling in New Countries. By William Crosley, M.Inst.C.E., M.Inst.M.M. Pp. vii + 159, 8vo, 7 × 4½. (London: Crosby Lockwood & Co., 1922.) Price 7*s*. 6*d*.

The late William Crosley spent a large portion of his career as mining engineer in outlying districts in Colombia, Rhodesia, Burma and Mexico, and this little book is largely the result of his own experiences and practice in these countries, and should prove of great use to settlers in new lands, especially as no work covering quite the same ground has hitherto appeared.

The opening chapters are devoted to measurements of areas, circular and angular measurement, the relation between the dimensions of angles and the length of lines, and the measurement of heights. Then follows a chapter on water, explaining the use of the rain-gauge, and the measurement of open streams by velocity, by the use of the "Pitot" tube, and by the notch-box. The use of the slope in dams and of grades in ditches are explained, and turn-outs, flumes and trestle aqueducts of simple construction are described and illustrated. The last chapter is on the measurement of solids in relation to road-making. In an appendix are described and illustrated the instruments most useful to settlers, including the hand compass, miner's dial, prismatic compass, dumpy level and aneroid barometer. The concluding section, entitled "Reprint from Notes upon Rhodesian Climate," consists actually of a discussion of storage dams for water required for irrigation purposes on farms, and includes references to rainfall and evaporation in relation thereto.

The work is clearly written and there are numerous illustrations accurately drawn by the author. The sketches showing the temporary dam of alluvial workings in South America, the weir utilising full width of stream, the notch for measuring water and the trestle aqueduct are especially interesting. There is much information in the book which will be found of particular service to engineers unaccustomed to work in remote parts of the world.

The Mineral Resources of Burma. By N. M. Penzer, M.A., F.R.G.S., M.R.A.S., F.G.S. With an Introduction by Colonel O. C. Armstrong, D.S.O., President of the Federation of British Industries. Pp. viii + 171, 8vo, 8½ × 5½. (London: Geo. Routledge & Sons, Ltd., 1922.) Price 31*s*. 6*d*.

There is no lack of published information on Burma and its minerals, but this work appears to be the first attempt to embody the information in one volume. A

brief sketch of the history, geography, climate, physical features, transport facilities and political organisation of the country is given, and there is also included a short summary of the geology of Burma and of the Shan States so far as it is known. Although the book adds little or nothing to what was previously known of the minerals of the country, it contains a useful summary of the information already published in the *Records* and *Memoirs of the Geological Survey of India* and other publications. The tables used in the book appear in several cases to be copies from the "Quinquennial Review of the Mineral Production of India, 1914–1918" (*Rec. Geol. Surv. Ind.*, 1921, **52**), which do not represent the latest official information on the subject. Statistics for at least two later years might have been given. The Burmese gem deposits, the Bawdwin lead-zinc mine, and the tin, tungsten and petroleum deposits of Burma are described fairly fully; the references to most other minerals in the book amount to little more than a mere list of occurrences with information as to the sources of information. This makes the book rather a guide to other works of reference than a reference book itself. The work is illustrated with six clearly drawn maps, of which one is a mineral map of the country, whilst the others are maps of individual mining districts. The glossary of native geological and mineralogical words in Appendices I and II should prove useful to those who contemplate practical mining in Burma. A bibliography referring to 442 publications adds to the usefulness of the book.

THE PETROLEUM INDUSTRY. By various contributors. Editor: A. E. Dunstan. Pp. 346, 8vo, 8¾ × 5¾. (London: The Institution of Petroleum Technologists, 1922.) Price 14*s*. 6*d*.

This work, as stated on the title-page, is a brief summary of the technology of petroleum, based on a course of lectures given by members of the Institution of Petroleum Technologists on the occasion of the Petroleum Exhibition, Crystal Palace, 1920, and includes a résumé of the address on "The Romance of Petroleum" by the late Sir Boverton Redwood, delivered before the Royal Institution in 1918. A lecture on "The Winning of Oil," by Hubert May, covers 62 pages, and is an admirable summary of the various methods used in drilling for oil, the advantages and disadvantages of the different rigs in actual use being clearly and concisely stated. Another useful lecture is that by H. Barringer on "Oil Transport, Storage and Distribution." The chemical part of the work covers "Petroleum

Refining" (by the Editor), "The Chemical Nature of Petroleum," "Uses of Petroleum Gases and Paraffin" (by W. R. Ormandy and covering upwards of 60 pages) and "The Uses of Heavy Oils" (by J. S. S. Brame). The last two lectures are on "Nomenclature" and "Statistics." At the end of the volume is a short bibliography compiled by W. H. Dalton, giving the contents of a number of textbooks dealing with petroleum.

The work is well printed and illustrated, and should prove a useful introduction to the geology and chemistry of petroleum.

Manual of Flotation Processes. By Arthur F. Taggart. Pp. xv + 181, 8vo, 9 × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1921.) Price 16*s.* 6*d.*

This book is essentially practical. It gives a more complete description than is usual in books on the subject, of appliances and methods at present in use, and includes some interesting flow sheets of actual mill practice involving flotation on a number of important mines. It also includes a useful section on the laboratory testing of ores as to their adaptability to flotation, and of the oils and other reagents in use.

Several writers on the subject have tended to confuse the less highly-trained technical reader by the undue use of mathematical formulæ. The present work, however, shows the process of flotation to be by no means so complicated and highly technical as such writers imply, and that a considerable elasticity in procedure is possible in actual practice. Although the various methods of flotation have long been in use, the book indicates that there is abundant scope for their improvement even in cases where flotation is already employed with considerable success, and that there are good chances of making it applicable to ores which are not responsive to existing methods of working.

The book will be welcomed in metallurgical circles as a useful and convenient addition to the literature of this important subject.

The Metallurgy of the Common Metals. By L. S. Austin. 5th Edition. Pp. xvii + 615, 8vo, 9 × 6¼. (London: Chapman & Hall, 1921.) Price 42*s.*

The metals dealt with in this volume comprise gold, silver, iron, copper, lead and zinc. Many changes have

been made in the subject-matter since the previous edition was issued.

Fuels and refractories used in smelting and the preparation of the ore are first discussed. The treatment of the metals is next considered in detail, the descriptions in many cases being rendered more valuable by reference to actual practice and by statistics of costs. In most cases the details given refer to American works. The chapters devoted to metallurgy are followed by others on plant and equipment and their cost.

The book is well written and illustrated, is practical in character and should prove serviceable to all requiring a concise, modern treatise on the subject.

A TEXTBOOK OF FIRE ASSAYING. By Edward E. Bugbee. Pp. ix + 254, 8vo, 9 × 6. (London: Chapman & Hall, Ltd., 1922.) Price 15s.

Unlike many works on assaying, which are little more than collections of fusion recipes, this book enters fully into the physical and chemical principles which underlie the various operations involved. After a useful chapter on the equipment of an assay laboratory, the principal operations in assaying, such as sampling, crucible and scorification fusions, cupellation, parting and weighing, are discussed in separate chapters. The assay of bullion and lead ores is also described. Considerable attention is given to possible sources of error. The book should form a good basis for a course for students of assaying and contains much of interest to those already experienced in the operations described.

MANUFACTURE OF PORTLAND CEMENT. By Arthur C. Davis, M.Inst.C.E.I., M.I.Mech.E., F.C.S., etc. Third edition, revised and enlarged. Pp. xiii + 416, 8vo, $8\frac{1}{2} \times 5\frac{3}{4}$. (Dublin: John Falconer, 1922.) Price 25s.

This volume deals very completely with the manufacture of Portland cement and the standard methods of testing the finished product.

Detailed descriptions of manufacturing processes, machinery and kilns, occupy the first half of the book. Chapters VIII to XII are almost wholly devoted to the description of the rotary kiln and its working, and include an interesting account of the work and early patents which preceded the introduction of the kiln into the Portland cement industry. Throughout this section, as in other portions of the book, the author's scheme of interrupting his description of processes of manufacture in order to

discuss the analysis and valuation of the raw materials is irritating to the reader. The whole of the analytical portion might with advantage have been kept distinct from that dealing with manufacture. Similarly, Chapter XVI on "Setting and Hardening," in which the colloid and crystalline theories of setting are discussed, would more appropriately form an introduction to "Setting Tests" (Chapter XX).

The preface states that the book is intended for the information of cement users, but it seems unlikely that the valuation of fuel (Chapter IX), flue gas analysis (Chapter XI) and technical investigations on clinker grinding would appeal to the general consumer of Portland cement.

The omission throughout the book of any reference to original sources of information detracts considerably from its value.

In the latter half of the work the physical and mechanical testing of cement is described. Chapter XVII in this section contains some short instructions and hints as to the use of Portland cement of interest to the consumer.

The influence of fine grinding on the mechanical properties of cement and concrete is fully discussed in Chapter XVIII, but the description of the Griffin-Goreham flourometer as a "recently devised" piece of apparatus is hardly correct, as it has been on the market for at least eleven or twelve years. The prominence given to the "weight per bushel" test and the description and diagrams of five types of flasks for the determination of specific gravity, both of which tests have been deleted from the latest British Standard Specification, and the diagram of a 1904 B.S.S. needle for determining the setting time are incompatible with the claim that the book has been thoroughly revised.

The latest British Standard Specification and those of the United States and French Governments, together with a series of useful tables, complete a work which should prove of considerable value to those interested in the technology of Portland cement.

Modern Coking Practice. By J. E. Christopher and T. H. Byrom. Third edition, in two volumes. Pp. xii + 130 and viii + 130, 8vo, $5\frac{1}{2} \times 8\frac{1}{2}$. (London: Crosby Lockwood & Son, 1921.) Price 10*s*. 6*d*. per volume.

The present edition of this book differs from the preceding edition in that appendices containing recent information have been added. The appendix to Volume I

deals with recent improvements in certain well-known coke ovens, whilst in that to Volume II the use and production of benzole for motor fuel are briefly considered.

Volume I deals with the analysis and sampling of coal and coke and describes the modern types of coke ovens and their accessory plant.

The recovery, purification, analysis and uses of the by-products obtained from coke, and the plant used in these operations are described in Volume II.

The descriptions of plant in both volumes are supplemented by many useful diagrams and photographic reproductions. This edition of the book should prove useful to those requiring a concise description of the practice at modern by-product coking works.

THE ANALYSIS OF COAL AND ITS BY-PRODUCTS. By S. R. Illingworth, M.Sc., A.R.C.S., F.I.C., *assisted by* J. Griffiths, F.C.S. Pp. viii + 380, 8 × 5. (London: The Colliery Guardian, Ltd., 1921.) Price 21s.

In this book a useful chapter on the sampling of coal, methods for its proximate and ultimate analysis and the determination of its calorific power is followed by descriptions of methods for the quantitative examination of the numerous by-products obtained at gas works and coke ovens, such as coal tar, light oils, ammoniacal liquor, spent oxide and gas. The concluding chapters deal with the control of combustion and the action of solvents on coal. The appendices include methods for determining the liability of coal to spontaneous combustion, the analysis of caustic soda and sulphuric acid, and tables of constants. In most cases the author gives alternative methods of estimation.

The work is characterised throughout by the thoroughness with which the subjects have been treated. Thus under "sulphur" are given full details for the estimation of total pyritic, volatile and combustible sulphur, and also of that present as sulphate and that in organic combination. The very complete analytical instructions are rendered more valuable by the inclusion, in many cases, of the reason for making such determinations and the influence of the constituents on the suitability of the coal for different purposes.

The book will prove of service to those engaged in the testing of coal and its products, and also contains much of interest to those engaged in their production.

AN INTRODUCTION TO THE ANALYTICAL CHEMISTRY OF THE RARER ELEMENTS. By Louis J. Curtman. Pp.

64, 8vo, $8\frac{1}{2} \times 5\frac{1}{2}$. (New York: The Author, 1922.) Price $1·25.

This little book is intended to meet the needs of students requiring an elementary course in the qualitative identification of the rarer elements. A large number of the more or less well-known reactions of the rarer elements are given, all of which the author claims to have personally verified.

In the majority of cases the instructions relate solely to salts of the rarer elements, and no directions are given as to how these are to be obtained from the minerals in which the elements occur. Hence the value of the book as a means of identifying the constituents of rare earth minerals is much reduced, although it will be useful as an introduction to the identification of salts of the rarer elements.

Mechanical Testing. By R. G. Batson, A.M.Inst.C.E., A.M.I.M.E., and J. H. Hyde, A.M.Inst.C.E., M.I.A.E., A.M.I.M.E. Vol. I. Testing of Materials of Construction. (The Directly Useful [D.U.] Technical Series.) Pp. xiii + 413, 8vo, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Chapman & Hall, Ltd., 1922.) Price 21s.

This book deals with the latest developments and progress of mechanical testing in an eminently practical way, and at the same time contains adequate scientific explanation. It fills a much-felt want, for it is only within recent years that the importance of more thorough and standardised investigation into the mechanical properties of materials of construction has been fully appreciated, and that endeavour has been made when carrying out tests to imitate more closely the conditions under which the materials are employed in practice. It should be of general utility, for its object, as the authors state in their preface, is to place before the technical engineer, manufacturer and student the conditions governing modern testing, together with particulars of standard testing plant and its limitations, and such information as will enable the results obtained to be apprised at their true values.

Commencing with a brief outline of the principles of load, stress, strain and elasticity, the authors pass on to a fairly complete description of modern testing machines of various types and their accessories which should be useful to those who are proposing to install testing apparatus. Information follows on methods employed in ordinary commercial testing, on tests on hard-drawn wire, on cast iron and on the influence of shape and time on the pro-

perties of materials. Measuring instruments and autographic recording apparatus, methods of determining the elastic constants, experiments on the repetition of stresses, resistance of materials to combined stress, rapid methods of determining fatigue ranges, alternating bending tests beyond the yield point, hardness and abrasion tests, impact and notched bar testing, effect of temperature on the mechanical properties of materials, are dealt with lucidly and concisely, and the volume concludes with particulars of the various methods of testing timber, stone, brick and concrete, road materials, and lime and cement.

BOOKS RECEIVED

THE RED BOOK, 1922–23: Handbook and Directory for Kenya Colony and Protectorate, Uganda Protectorate, Tanganyika Territory and Zanzibar Sultanate. Pp. 617, $9\frac{1}{2} \times 6\frac{1}{2}$. (Nairobi and Mombasa: The "East African Standard," Ltd., 1922.)

THE NATIONAL RESOURCES OF SOUTH AFRICA. By R. A. Lehfeldt, D.Sc. Pp. 79, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Longmans, Green & Co., 1922.) Price 5*s.*

A MANUAL OF INDIAN TIMBERS. By J. S. Gamble, M.A., C.I.E., F.R.S., F.L.S. Reprint of second edition, with some additions and corrections. Pp. xxvi + 868, $8\frac{3}{4} \times 5\frac{3}{4}$. (London: Sampson Low, Marston & Co., Ltd., 1922.) Price 63*s.*

THE FUNDAMENTALS OF FRUIT PRODUCTION. By Victor Ray Gardner, Frederick Charles Bradford and Henry Daggett Hooker, Jr. Pp. xvi + 686, 8vo, $9\frac{1}{4} \times 6$. (New York and London: McGraw-Hill Book Company, Inc., 1922.) Price 22*s.* 6*d.*

THE LEATHER TRADES YEAR BOOK. Fourteenth Edition. (Formerly "The Tanners' Year Book.") Hon. Editor, Dr. J. Gordon Parker. Pp. lxiii + 192, $9\frac{1}{2} \times 6\frac{1}{2}$. (London: The United Tanners' Federation of Great Britain and Ireland, 1922.) Price 6*s.*

COAL: ITS PROPERTIES, ANALYSIS, CLASSIFICATION, GEOLOGY, EXTRACTION, USES AND DISTRIBUTION. By Elwood S. Moore, M.A., Ph.D. Pp. v + 462, 9×6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1922.) Price 25*s.*

Gasolene and other Motor Fuels. By Carleton Ellis and Joseph V. Meigs. Pp. xix + 709, 8vo, 9½ × 6. (London: A. Constable & Company, Ltd., 1921.) Price 60s.

A Handbook of Petroleum, Asphalt and Natural Gas. By Roy Cross. Pp. 622, 7¾ × 6. (Kansas City: Kansas City Testing Laboratory, 1922.) Price $7·50.

Zirconium and its Compounds. By Francis P. Venable. Pp. 173, 9 × 6. (New York: The Chemical Catalog Company, Inc., 1922.) Price $2·50.

The Electro-Metallurgy of Steel. By C. C. Gow, Assoc. R.S.M., M.I.M.M., B.Sc. Pp. x + 351, 8½ × 5½. (London: Constable & Company, Ltd., 1921.) Price 27s. 6d.

Metallurgy of Zinc and Cadmium. By H. O. Hofman, E.M., Met.E., Ph.D. Pp. xii + 341, 8vo, 9 × 6. (New York and London: McGraw-Hill Book Company, Inc., 1922.) Price 20s.

An Introduction to the Chemistry of Radio-Active Substances. By A. S. Russell, M.A., D.Sc. Pp. xi + 173, 7¾ × 5¼. (London: John Murray, 1922.) Price 6s.

The Analysis of Non-Ferrous Alloys. By Fred Ibbotson, D.Met., B.Sc., F.R.C.Sc.I., F.I.C., and Leslie Aitchison, D.Met., B.Sc., A.I.C. Second Edition. Pp. ix + 246, 8½ × 5½. (London: Longmans, Green & Co., 1922.) Price 12s. 6d.

The Advancement of Science: 1922. Addresses delivered at the 90th Annual Meeting of the British Association for the Advancement of Science. Hull, September 1922. 8½ × 5½. (London: John Murray.) Price 6s.

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

The following summaries have been prepared from a selection of the Reports made by the Director of the Imperial Institute to the Dominion, Colonial and Indian Governments.

PAPER-MAKING MATERIALS FROM INDIA AND NIGERIA

In continuation of the series of reports on paper-making materials from various parts of the Empire which have been published from time to time in this Bulletin, the results of investigation of talipot palm leaf stalks and betel nut husks from India and of elephant grass from Nigeria are given below. Recent articles on paper-making materials will be found in this Bulletin (1921, **19**, 1, 12, 15, 271; 1920, **18**, 323; and 1919, **17**, 141), the last-mentioned containing references to earlier reports on the subject.

India

(1) *Talipot Palm Leaf Stalks*

The talipot palm of Ceylon and Southern India (*Corypha umbraculifera*) is a tall palm with large fan-shaped leaves, sometimes 10 ft. in diameter. As in the case of so many of the tropical palms, different parts of the plant are put to a variety of native uses, the leaves being made into fans, mats, umbrellas, baskets, etc., while the hard seeds are used as a substitute for ivory in the local manufacture of beads and other small articles, and are shipped to Europe for the manufacture of buttons.

Leaf stalks of the talipot palm, forwarded to the Imperial Institute by the Divisional Forest Officer, S. D. Kanara, Madras, have recently been examined as a paper-making material. The stalks received were hard, smooth,

light yellowish-brown and fibrous, and had been cut into pieces measuring 3 ft. in length and varying in width from ½ to 1 in.

They were analysed with the following results:

	Per cent.
Moisture	10·1
Ash	4·7
Cellulose, expressed on stalks as received	46·8
Cellulose, expressed on moisture-free stalks	52·1

The length of the ultimate fibres ranged from 0·7 to 2·7 mm., being mostly from 1·0 to 2·0 mm., with an average of 1·5 mm.

The stalks were treated with caustic soda under conditions similar to those employed in the production of paper pulp on a commercial scale, with the results given in the following table, which are expressed in each case on the stalks as received:

Trial.	Caustic soda used.		Conditions of boiling.		Caustic soda consumed per 100 parts of stalks.	Yield of dry pulp.	
	Parts per 100 parts of stalks.	Parts per 100 parts of solution.	Time.	Temp.		Unbleached.	Bleached.
			Hrs.	° *C.*		*Per cent.*	*Per cent.*
A	20	4	6	140	13·9	45·5	39
B	20	4	6	160	15·9	43	38

The pulp obtained under the conditions of Trial A contained a small proportion of insufficiently disintegrated fibre, and would not bleach satisfactorily. By increasing the temperature of digestion to 160° C., as in Trial B, a better result was obtained and pulp consisting of well-separated fibre was readily produced. The pulp had good felting power and furnished a strong brown paper, but it would not bleach readily, only a dark cream-coloured pulp being obtainable under ordinary conditions, *i.e.* by using 24 per cent. of bleaching powder (expressed on the original material). By employing 40 per cent. of bleaching powder it was however found possible to obtain a fairly white pulp, yielding an opaque paper of good strength.

The results show that talipot palm stalks are a promising paper-making material, and furnish a fairly good

yield of pulp. The unbleached pulp yields a strong brown paper, suitable for wrapping purposes.

Although it is possible to prepare from the pulp a paper of fairly white appearance and good strength, the pulp bleaches with difficulty and requires a relatively large quantity of bleaching powder. It therefore seems doubtful whether the manufacture of white paper from the stalks would be remunerative.

(2) *Betel Nut Husks*

The betel nut palm tree (*Areca Catechu*), which occurs over a wide area in the East, yields annually on the average about 300 fruits per tree, each containing one seed about the size of a hen's egg. It is cultivated principally on account of the seed, the use of which as a masticatory is widespread among Oriental nations. Although large quantities of betel nuts are produced and collected in India, about 1,000,000 cwts. are imported each year, principally from the Straits Settlements and Ceylon. Attempts are being made to find uses for the large quantities of husks that become available in India, and towards the end of last year the Imperial Institute was consulted by the Fibre Expert to the Government of India as to the possibility of utilising them for paper-making.

The husks received were about 1½ in. in length, and of a light brown tint. Each husk was composed of a mass of weak woolly fibres, mixed with some coarser and stronger bristle-like fibres, the latter being attached to a thin woody layer with a smooth and fairly hard inner surface.

The material gave the following results on analysis:

	Per cent.
Moisture	10·5
Ash	6·8
Cellulose, expressed on husks as received	42·6
Cellulose, expressed on moisture-free husks	47·6

The ultimate fibres measured from 0·3 to 1·4 mm., with an average of 0·6 mm.

The husks were treated with caustic soda under conditions similar to those employed for the production of

paper pulp on a commercial scale, and the results are given in the following table:

Trial.	Caustic soda used.		Conditions of boiling.		Caustic soda consumed per 100 parts of husks.	Yield of dry pulp expressed on husks as received.	
	Parts per 100 parts of husks.	Parts per 100 parts of solution.	Time.	Temp.		Unbleached.	Bleached.
			Hrs.	° C.		*Per cent.*	*Per cent.*
A	16	2	6	140	—	—	—
B	18	3	6	160	10·4	43	33
C	22	$3\frac{2}{3}$	6	160	16·0	36	—

The pulp obtained in Trial A was not sufficiently broken up for treatment in the beater. In Trial B most of the material was disintegrated, but a small amount of the coarser fibre still remained unbroken, and the paper obtained was of poor strength. When treated with 30 per cent. of bleaching powder the pulp could only be bleached to a pale buff tint. The pulp obtained by the more drastic treatment adopted in Trial C was slightly better, but it still contained a small proportion of unbroken fibre and the paper made from it was weak.

The different parts of these husks resist the action of caustic soda in varying degrees, and it is therefore not possible to regulate the conditions in such a way as to ensure the production of a pulp composed of uniformly disintegrated fibre. The finer fibres are reduced with relative ease, whilst the coarser fibres and the woody inner layer, which are more resistant, are not completely disintegrated even under the fairly drastic conditions of Trial C. The extreme shortness of the ultimate fibres renders it somewhat difficult to obtain a coherent sheet of paper from the pulp, and the paper produced in the laboratory trials was very weak. Furthermore the pulp cannot be bleached satisfactorily.

On the whole, the results of the trials indicate that betel nut husks are not a very suitable material for paper-making, and that they could only be employed in conjunction with longer-fibred materials for the production of low-grade brown papers or boards. Their utilisation in this manner however does not appear promising.

NIGERIA

Elephant Grass

In a previous article, entitled "Giant Grasses for Paper-making" (this BULLETIN, 1921, **19**, 187), an account was given of the possibilities of elephant grass, *Pennisetum purpureum*, Schumacher (= *P. Benthamii*, Steudel), for the production of paper pulp, and reference was made to the promising results obtained in paper-making trials at the Imperial Institute some years ago with samples of the grass received from Uganda. In continuation of investigations carried out recently at the Imperial Institute to determine the suitability of a number of Nigerian grasses for paper-making (see this BULLETIN, 1921, **19**, 271), a sample of elephant grass from the Southern Provinces has been examined with the following results.

The material received consisted of straw-coloured cane cut into lengths of 2½ ft., and measuring from ¼ to 1 in. in diameter, with nodes every few inches. A large proportion of pith was present.

The grass was chemically examined with the following results:

	Per cent.
Moisture	8·7
Ash	2·9
Cellulose, expressed on grass as received	54·0
Cellulose, expressed on moisture-free grass	59·1

The ultimate fibres measured from 0·5 to 3·2 mm., with an average of 1·4 mm.

The material was treated with caustic soda under conditions similar to those used for the production of soda pulp on a commercial scale, with the following results, which are expressed on the grass as received:

Caustic soda used.		Conditions of boiling.		Caustic soda consumed per 100 parts of grass.	Yield of dry pulp.	
Parts per 100 parts of grass.	Parts per 100 parts of solution.	Time.	Temp.		Unbleached.	Bleached.
		Hrs.	° *C.*		*Per cent.*	*Per cent.*
16	4	5	160	10·0	48·3	45·7

The crude pulp thus obtained consisted of well disintegrated fibre and yielded a pale brown paper of good strength. The pulp was readily bleached, and the bleached pulp after beating was satisfactory in texture and felting properties and furnished a white paper of good quality.

The conditions employed for the treatment of this grass as a paper-making material were similar to those which had yielded the best results with previous samples of elephant grass examined at the Imperial Institute. The yield of pulp is practically the same as that obtained under similar conditions from the elephant grass from Uganda.

This Nigerian grass is a satisfactory material for paper-making, but it would not be remunerative to export it to the United Kingdom. It could, however, be utilised in Nigeria for the production of "half-stuff" for export.

OIL OF THE MEXICAN POPPY

The Mexican or prickly poppy (*Argemone mexicana*) is an annual plant, which has been introduced from its original home in Mexico to almost all tropical and subtropical countries, in many of which it now grows wild. The plant contains, like other members of the poppy family, a yellow juice, which is used medicinally in some countries, whilst the seeds, which contain a fixed oil, have narcotic properties and are sometimes employed in India as a drug.

Seeds of *Argemone mexicana*, collected in South Africa, in parts of which the plant is very common on waste ground, were forwarded recently to the Imperial Institute in order that their value as a source of oil for technical purposes might be determined. They were small and round, dark brown in colour, and had an average weight of 0·002 gram.

The seeds as received contained 7·7 per cent. of moisture and on extraction with light petroleum yielded 36·5 per cent. of a limpid oil, corresponding to a yield of 39·5 per cent. on the moisture-free seed.

The extracted oil was brownish-yellow and had a

slightly acrid odour. It was examined with the following results:

Specific gravity at 15/15° C.		0·9220
Refractive index, $n_{[D]}$ 40° C.		1·466
Solidifying point of fatty acids		22·8° C.
Acid value		21·6
Saponification value		192·7
Iodine value	*per cent.*	123·7
Unsaponifiable matter	*per cent.*	1·14
Volatile acids, soluble		nil
Volatile acids, insoluble		1·16

The meal left after the extraction of the oil from the seeds was analysed with the following results:

	Per cent.
Moisture	10·2
Crude proteins	24·6
Ash	7·7

Drying trials were carried out by exposing thin films of the oil and also of raw linseed oil to the action of air and sunlight. The linseed oil dried to a clean hard coat in three days, but the film of *Argemone mexicana* oil was, after a week, still slightly tacky and had darkened appreciably in colour.

Attempts to improve the drying properties of the Argemone oil by treatment with litharge and manganese driers under different conditions did not prove very successful, only a slight improvement being obtained. The oil, moreover, did not produce a satisfactory polymerised product on heating, either with or without the addition of driers.

The oil of *Argemone mexicana* is employed to some extent in medicine in India and the West Indies, and is reported to possess purgative properties. It is also used as a lubricant and illuminant in Mexico and the West Indies. From its moderately high iodine value, the oil would be classed as a semi-drying oil, and it is stated to be employed in South America for paint preparation. The above experiments, however, indicate that the oil would not prove very satisfactory for this purpose, though it might be employed in admixture with linseed oil as a cheap substitute for the latter. The bitter taste and therapeutic action of the oil render it unsuitable for edible

purposes. It therefore appears probable that the only important commercial use for the oil would be in the soap-making industry.

The meal left after the preparation of the oil from the seeds could not be utilised as a cattle food, as any oil remaining in it would exert a purgative action, and in addition an alkaloid is present. The material could therefore only be utilised as a manure, for which purpose it would be of value on account of the large proportion of nitrogenous constituents present.

COFFEE FROM UGANDA, THE SUDAN AND CEYLON

Uganda

In a previous number of this Bulletin (1918, **16**, 24) reference was made to the important position occupied by the coffee-growing industry in Uganda. Although, according to the *Report of the Department of Agriculture, Uganda Protectorate, for the nine months ended December* 31, 1920, prices were so low towards the end of the year that producers were able to realise very little profit, coffee still remains the principal crop on European plantations, and there is every reason to believe that coffee production in the Protectorate will increase under normal conditions.

In the year 1920 there were on European plantations 16,877 acres of Arabian coffee over two years old and 2,116 under two years; a large proportion of the older coffee is interplanted with Para rubber, and the coffee is being gradually cleared out as the rubber trees reach maturity. The area planted with Robusta coffee was 260 acres, as compared with 445 acres in the previous year.

It is estimated that in 1920 the natives were growing coffee on 12,804 acres, whilst 1,826 acres were under the crop on plantations cultivated by Indians and 735 acres were devoted to coffee at the Mission stations.

The previous article contained a table showing the rapid increase in the exports of coffee from Uganda (from £2,563 in 1911–12 to £113,939 in 1916–17); the figures for recent years are as follows:

	Quantity. Cwts.	Value. £
1916–17.		
Husked	31,136	81,323
In parchment	17,473	32,616
1917–18.		
Husked	15,362	33,278
In parchment	4,485	6,283
1918–19.		
Husked	50,460	102,658
In parchment	3,851	3,351
1919–20.		
Husked	54,694	156,668
In parchment	4,266	5,046
1920 (nine months ending December 31).		
Husked	21,399	81,384
In parchment	2,373	5,617

Considerable attention has been devoted to the growth and preparation of coffee at the Government Plantations, and a coffee expert has recently been appointed. The plots of *Coffea excelsa* and *C. liberica* planted at Kampala in 1915 and 1916 have so far given poor yields, and altogether do not appear likely to furnish such promising results as most of those planted previously with varieties of *C. arabica* and *C. robusta*. Although the comparative yields per acre for *C. robusta* have not, on the whole, been greatly in excess of those for *C. arabica*, the officer in charge of the plantation is of opinion that the former will give much higher yields in the Protectorate, providing that the seed is obtained from a reliable source.

In continuation of the investigation of the coffee produced at the Government Plantations (see this BULLETIN, 1916, **14**, 6; 1918, **16**, 25; 1919, **17**, 179) samples of ungraded coffee in the parchment, representing the above varieties grown at Kampala, were received in November, 1921; their characters are tabulated on page 296, and their commercial values were as follows:

No. 1.—This Arabian coffee was regarded in the trade as of good appearance and quality, and it was considered that it should meet with a ready sale at about 88*s.* to 90*s.* per cwt. in London (March, 1922). It was pointed out that the sample contained a certain amount of withered and broken beans which lowered its market value.

Nos. 2 *and* 3.—The Excelsa coffee represented by these samples was considered unattractive and undesirable for

Sample No.	Description.	Percentage of parchment in berries.	Average weight of beans in grams.	Size of beans.
1. *Coffea arabica.* Bourbon.	Seed coat light brown, loosely adhering. Beans greyish cream, translucent.	18	0·14	Small
2. *Coffea excelsa.* Plot 1. (Culture No. 2).	Seed coat greenish brown to light brown, tightly adhering. Beans greenish cream to green, opaque.	26	0·16	Small
3. *Coffea excelsa.* Plot 3. (Pylendel 2).	Seed coat greenish brown, tightly adhering. Beans similar to No. 2.	28	0·21	Medium
4. *Coffea liberica*	Seed coat light brown, tightly adhering. Beans cream-coloured, opaque.	33	0·23	Medium
5. *Coffea robusta.* Java 104. Field 25.	Seed coat brown, tightly adhering. Beans greyish cream, opaque.	14	0·12	Small
6. *Coffea robusta.* No. 1. Progeny of Toro.	Seed coat light brown to brown, tightly adhering. Beans greyish cream, opaque.	14	0·14	Small
7. *Coffea robusta.* No. 3. Progeny of Toro.	Seed coat light to dark brown, tightly adhering. Beans similar to No. 6.	14	0·12	Small
8. *Coffea robusta.* No. 9. Progeny of Toro.	Seed coat and beans similar to No. 7.	13	0·14	Small
9. *Coffea robusta.* No. 16. Progeny of Toro.	Seed coat and beans similar to No. 7.	14	0·14	Small
10. *Coffea robusta.* Toro.	Seed coat and beans similar to No. 7.	13	0·12	Small

the London market, its value being only about 47*s.* to 50*s.* per cwt. (March, 1922).

No. 4.—Liberian coffee is not saleable in London for the United Kingdom market, but is occasionally in demand for export to foreign countries. Consignments of fair quality similar to the present sample would realise about 60*s.* to 63*s.* per cwt. in London for this purpose (March, 1922).

Nos. 5–10.—These samples of Robusta coffee were regarded as of inferior character and as worth only about 45*s.* to 50*s.* per cwt. in London (March, 1922). The samples differed widely in quality from the exceptionally good sample of Robusta coffee which was the subject of a previous report (this BULLETIN, 1919, **17**, 181). It

is not considered in the trade that the production of Robusta coffee resembling the present samples should be encouraged.

The only coffee in the present set which was regarded favourably on the market was No. 1, representing the Arabian variety. It would therefore appear desirable that special attention should be devoted to this variety in any further trials which may be carried out at Kampala, and that its production in the Protectorate should be encouraged. If well prepared and graded, the Arabian variety realises the highest prices for coffee in the London market and has a steady sale at all times.

The Excelsa and Liberian coffees, Nos. 2–4, were of much lower value than the Arabian, and as the market for these varieties is more restricted, they cannot be recommended for extended cultivation in Uganda.

Sudan

It was suggested in a previous report on a sample of Liberian coffee grown at Kegulu Farm (this Bulletin, 1919, **17**, 183) that before adopting this variety for extended cultivation in the Sudan it would be desirable to conduct experiments with Arabian coffee at suitable localities for comparison in order to determine which would be most suitable for general cultivation. In response to this suggestion, two samples of Arabian and Liberian coffee stated to have been grown in the Lado were received in July 1921 for investigation and valuation.

No. 1. *Arabian.*—This sample consisted of ungraded coffee in the parchment, well washed and clean; a few peaberries were present. The parchments formed 20 per cent. by weight of the sample, and were pale brownish-yellow. The beans were small, their average weight being 0·16 gram; they were well formed, greenish-grey, horny and translucent. The seed coat was pale brown and very loosely adherent.

No. 2. *Liberian.*—This sample consisted of ungraded coffee in the parchment, and was fairly well washed. The parchments, which formed 34 per cent. by weight of

the sample, were yellowish-brown and in some cases stained. The beans were fairly large, their average weight being 0·25 gram; they were irregular in shape, coarse, and varied in colour from grey or greenish-cream to brownish-green. The seed coat was lightly adherent and varied in colour from green to reddish-brown.

The Arabian coffee was regarded by experts as of fair size but uneven, and was considered to represent coffee of good quality which, if husked and graded in London by machinery, would furnish a satisfactory product suitable for most markets. It was stated that the cost of husking and grading this coffee in London, including landing, warehousing, and other similar charges, would be only 4*s.* 6*d.* per cwt., and that the husked and graded product would be worth 75*s.* to 80*s.* per cwt. in London (July, 1921).

A less favourable opinion was expressed regarding the Liberian coffee. The beans were rather small and irregular in comparison with Liberian coffee from other sources. In view of the large quantity of husk present, and the high cost of husking such coffee in the United Kingdom, estimated at 9*s.* per cwt., the product would have to be husked before export in order to save freight and other charges, and even then would only realise 50*s.* to 55*s.* per cwt. in London (July, 1921).

The sample of Arabian coffee was far superior to the Liberian, and, in view of the limited demand in the United Kingdom for coffee of the latter type, even when of good quality, the Institute suggested that it would be preferable to devote attention in the Sudan to the cultivation of Arabian coffee.

Ceylon

Experiments are being conducted at Peradeniya, Ceylon, with various kinds of coffee, and five sorts produced there in 1921 have been received at the Imperial Institute for examination.

The samples represented five varieties of ungraded coffee in the parchment. Their characteristics are given in the following table :

No.	Label.	Description.	Percentage of parchment in berries.	Average weight of beans freed from parchment, in grams.
1.	"Robusta"	Seed coat dull brown, tightly adhering in most cases, but loosely in others. Beans dull greyish-cream	12·0	0·15
2.	"Hybrid"	Seed coat light brown, tightly adhering. Beans greyish-cream to cream, opaque	13·0	0·13
3.	"Canephora"	Seed coat light brown, tightly adhering. Beans greyish-cream to cream	10·6	0·14
4.	"Quillou"	Seed coat brown, tightly adhering in some cases, but in others fairly loose. Beans greyish-cream to cream, opaque	10·9	0·15
5.	"Uganda"	Seed coat light brown, tightly adhering. Beans greyish-cream to cream	14·0	0·14

The beans were analysed with the following results:

	No. 1. Robusta. *Per cent.*	No. 2. Hybrid. *Per cent.*	No. 3. Canephora. *Per cent.*	No. 4. Quillou. *Per cent.*	No. 5. Uganda. *Per cent.*
Moisture	10·1	10·1	10·4	10·4	10·6
Caffeine	2·1	2·3	2·3	2·4	2·3
Crude proteins	13·4	11·5	11·4	11·2	12·4
Fat	6·7	6·1	7·8	6·9	7·1
Carbohydrates, etc. (by difference)	49·6	52·1	49·3	51·5	50·8
Fibre	14·6	14·5	15·3	14·1	13·5
Ash	3·5	3·4	3·5	3·5	3·3

For comparison with these results the following figures recorded for some of the above varieties of coffee and for Arabian coffee (*Coffea arabica*) may be quoted:

	Robusta. *Per cent.*	Canephora. *Per cent.*	Quillou. *Per cent.*	C. arabica *Per cent.*
Moisture	13·1	8·7	—	8–12
Caffeine	1·5–2·4	2·3	2·4–2·8	1·0–1·5
Crude proteins	—	9·9	—	7–12
Fat	7·79	7·8	—	11–14
Carbohydrates, etc. (by difference)	—	48·7	—	38–51
Fibre	—	18·4	—	18–22
Ash	—	4·2	—	3·5–4

The five coffees from Ceylon are similar in chemical composition, and contain, in comparison with *C. arabica*,

a high percentage of caffeine and a somewhat larger amount of proteins. The percentage of fat and fibre are considerably lower than in *C. arabica*.

It was stated in the trade that these coffees are not particularly suitable for use in the United Kingdom, but that they would find a market here for re-export. They should be husked and cleaned before shipment, and would then be readily saleable on the Continent of Europe in large quantities, up to 250 to 500 bags at a time. If forwarded in the parchment the coffees would realise only about 45*s*. per cwt. in the United Kingdom, but if husked and cleaned their value per cwt. would be approximately as follows (July 1922): No. 1, Robusta, 60*s*.; No. 2, Hybrid, 58*s*.; No. 3, Canephora, 62*s*.; No. 4, Quillou, 65*s*.; No. 5, Uganda, 63*s*.

EFWATAKALA GRASS AS A FODDER

As a result of observations made by Mr. M. T. Dawe, F.L.S., in a recent tour in Angola, he has suggested that a grass common in that country may possibly be of value in the attempts to eradicate the tsetse fly from tropical Africa (*Tropical Life*, 1922, **18**, 69). The grass, which is known to the natives as "efwatakala," appears to be a form of the well-known "gordura" grass of South America (*Melinis minutiflora*). The plant when fresh has a strong odour and the leaves are covered with glandular hairs which secrete a viscid oil. Mr. Dawe's view is that the odour, together with the sticky hairs, would tend to drive the tsetse fly from the ground on which the grass grows. He has suggested, therefore, that trials should be made in cultivating the plant in different parts of tropical Africa with a view to testing the truth of his assumption. Even if the grass should fail in this respect, it would appear to be worth growing as a fodder crop. It is quick growing, and owing to its habit of rooting along the stem, it tends to smother other vegetation and produce a close herbage suitable for pasturing cattle.

The grass is common in Brazil and Colombia, and is

also native in Africa, from south of the Sahara to Natal, as well as in Madagascar. In the first two countries its value as fodder is well recognised, whilst it has been tried, usually with good results, in several other countries. The grass is stated by one authority to be unusually palatable to cattle and horses, and it has been found that when fed to dairy cows as roughage it increases the live weight and milk production. In the fresh state it is said that some animals will not eat it, owing to the odour, but this, as well as the oily character, disappears when the grass is dry.

The *Report of the Hawaii Agricultural Experiment Station*, 1915, states that the grass has gained considerable favour in the Hamakna district of Hawaii, the farmers there preferring it to either Australian water-grass or Para grass. It has given excellent results in trials conducted at Salisbury, Southern Rhodesia, yielding 5 tons of dried hay per acre in 1916–17 and 3½ tons in 1917–18. According to the *Rhodesia Agricultural Journal* (1918, **15**, 328), it is perhaps the best hay grass yet introduced into Rhodesia, where it is being grown under the name of "molasses" grass. It was introduced into parts of Australia about 1900, under the name of "stink" grass. As a result of trials in Queensland it was considered likely to prove a good fodder grass, whilst it has also been tried with promising results at various places in New South Wales (*Queensland Agric. Journ.*, 1901, **9**, 215; *Agric. Gazette, N.S.W.*, 1911, **22**, 1032). The grass has also been tried in the Philippines, but without much success (*Philippine Agric. Rev.*, 1912, **5**, 27). In this case difficulty was experienced in the germination of the seed, which does not appear to have occurred elsewhere, and it is possible that the climatic conditions under which the grass was tried were unsuitable.

The grass has been examined recently at the Imperial Institute in order to determine its composition as a feeding-stuff. The material investigated was collected at Mr. Dawe's request at Kibokolo in the Portuguese Congo. There appears to be some doubt as to the purity of the sample, as Mr. Dawe states that in addition to *Melinis minutiflora*, another species, *M. effusa*, grows at the spot

where the grass was collected, and as the natives do not differentiate between the two, calling them both "efwatakala," it is possible that some of the *M. effusa* grass may have been included in the material sent.

The grass measured from 15 to 25 in. in length, with light straw-coloured stems and narrow greyish-green leaves. Both stalk and leaf were strongly pubescent, but no volatile oil or sticky exudation was present, these having evidently been lost on drying.

The grass was analysed with the following results, which are shown in comparison with corresponding figures recorded for (*a*) millet hay, (*b*) timothy grass hay and (*c*) elephant grass (of 8 weeks' growth).

	"Efwatakala" grass. *Per cent.*	Millet hay. *Per cent.*	Timothy grass hay. *Per cent.*	Elephant grass. *Per cent.*
Moisture	7·7	13·4	14·3	8·0
Crude proteins	5·7	10·8	8·5	7·1
Oil	1·9	2·2	2·4	1·0
Fibre	33·6	29·4	28·5	31·0
Carbohydrates (by difference)	43·8 [1]	38·5	41·1	38·7
Ash	7·3	5·7	5·2	14·2
Food units	63	71	68	59
Nutrient ratio	1 : 8·5	1 : 4	1 : 5·5	1 : 5·8

[1] *Including* 1·1 *per cent. of reducing sugars, calculated as dextrose. No non-reducing sugars were present.*

These results show that "efwatakala" grass is of fair quality as a fodder, although it contains less proteins and more fibre than elephant grass (8 weeks old) and is also inferior in these respects to millet hay and timothy grass hay.

TILE- AND BRICK-MAKING MATERIALS OF NIGERIA

Reference was made in an earlier number of this BULLETIN (1921, **19**, 297) to the search that is being made in parts of Africa for clays and other materials suitable for the local manufacture of roofing tiles, and an account was given of investigations made at the Imperial Institute

as to the value of materials from Uganda and Kenya Colony for this purpose.

Specimens of clay and locally made tiles were forwarded to the Imperial Institute last year by the Government of Nigeria. It was stated that the clays, which were obtained from Ebute Metta, had been used for some time for brick-making, but that the bricks produced were rather brittle. The tiles made locally from these clays were also not entirely satisfactory. It was therefore desired to ascertain whether, by suitable admixture of other materials, high-grade bricks and tiles could be produced from the clays.

Old Clay.—This was a hard, buff-coloured clay, containing fragments of quartz, iron oxide and felspar. It formed a fairly plastic mass with water and was not too sticky for working.

New Clay.—This was a soft, light buff-coloured clay, mottled with grey and red. It contained a large amount of quartz and iron oxide fragments, together with some vegetable matter (twigs, leaves, roots, etc.). It formed a fairly plastic mass when mixed with water.

Tiles.—The specimens of locally made tiles (both burnt and unburnt) were much broken when received at the Imperial Institute; they contained numerous fragments of quartz and ferruginous matter.

Old Clay

Tile-making Tests.—Tiles were made from the "Old" clay as received, and after air-drying were fired at a temperature of 1,000° C. for 6 hours, the total period of firing being about 24 hours. The tiles produced (No. 1) were strong and suitable for roofing purposes, but were slightly marred by small cracks, which in most cases radiated from fragments of quartz. With a view to obviating this defect the raw clay was ground to pass a sieve having 20 meshes to the linear inch. Tiles (No. 2) made from the ground material and fired as before were very strong, free from defects, and suitable for roofing purposes.

The results obtained in the examination of the tiles (Nos. 1 and 2) are tabulated below:

"Old" Clay Tiles

Material.	Water added (per cent. of dry clay).	Temperature of firing (maximum).[1]	Duration of firing at maximum temperature.[1]	Shrinkage on air-drying.	Additional shrinkage on firing.	Total shrinkage.	Water absorption	Ring.	Colour.
			Hours.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*		
No. 1.—Raw clay, unground	17·5	1,000°C.	6	7·0	2·8	9·8	13·65	Good	Light venetian red
No. 2.—Raw clay, ground	21·5	1,000° C.	6	7·1	3·1	10·2	13·50	,,	,,

[1] *Total period of firing about* 24 *hours.*

The shrinkage of the clay was somewhat high, but this could if necessary be reduced by the addition of "grog," made from the raw clay previously fired at 1,000°C. for 6 hours and ground to pass a sieve having 8 meshes to the linear inch.

The results of the trials show that this "Old" clay possesses good binding qualities, and that after grinding to pass a 20-mesh sieve it is suitable for the manufacture of roofing tiles. If grinding is impracticable the coarse quartz, etc., could be removed by washing if a good supply of water is available.

Brick-making Tests.—The results obtained in the foregoing tests indicated that the "Old" clay would also be suitable for brick-making. Bricks were therefore made from the clay, both unground and also after grinding to pass a sieve having 8 meshes to the linear inch. These when fired at a temperature of 1,000° C. for 5 hours gave products (Nos. 3 and 4) which were strong and had a good ring, but in both cases they were marred by small cracks, usually radiating from fragments of quartz. Slight warping had also taken place, indicating the necessity for careful, slow firing.

The bricks made from the ground material would be suitable for local use, but further trials showed that superior bricks could be made by grinding the clay to pass a 20-mesh sieve.

As the faults in the bricks made from either the ground

or unground raw clay appeared to be due to the presence of coarse particles of quartz, the siliceous matter, which amounted to about 14 per cent., was removed by washing, and bricks were made from the washed clay in admixture with 20 per cent. of "grog." These bricks (No. 5), which were fired under the same conditions as before, were strong and free from defects, with the exception of slight warpage.

The results obtained in the examination of the bricks made as described above from the "Old" clay were as follows:

"Old" Clay Bricks

Material.	Water added (per cent. of dry clay).	Temperature of firing (maximum).[1]	Duration of firing at maximum temperature.[1]	Shrinkage on air-drying.	Additional shrinkage on firing.	Total shrinkage.	Water absorption.	Ring.	Colour.
			Hours.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*		
No. 3.—Raw clay, unground . . .	21·8	1,000° C.	5	6·4	2·6	9·0	15·7	Good	Light brick-red
No. 4.—Raw clay, ground to pass 8-mesh sieve .	21·8	1,000° C.	5	6·0	4·0	10·0	14·9	"	"
No. 5.—Mixture of washed clay 80 per cent. and grog 20 per cent.	23·6	1,000° C.	5	6·0	2·0	8·0	15·7	"	"

[1] *Total period of firing about 24 hours.*

These results indicate that the "Old" clay is suitable for the manufacture of ordinary building bricks. Rather slow firing is necessary, however, as the bricks have a tendency to warp. If the clay is used in the unground or coarsely ground state weakness is caused by the presence of particles of siliceous matter, but this can be remedied to some extent by finer grinding or can be entirely obviated by removing the siliceous matter by washing. Strong bricks can be made by mixing suitable quantities of "grog" with the washed clay.

New Clay

Tile-making Tests.—Tiles (No. 6) were made from the "New" clay as received, and after air-drying were fired at a temperature of 1,000° C. for 6 hours. The tiles obtained were, however, too weak for roofing purposes.

A further quantity of the raw clay was ground to pass a sieve having 20 meshes to the linear inch, and tiles made from this material were fired as before. The tiles produced (No. 7) were stronger than those made from the unground clay, but were still too weak for roofing use.

The "New" clay appeared from these results to be deficient in binding qualities, and as the "Old" clay was quite satisfactory in this respect, a mixture was made of equal parts of the two clays, both being ground to pass a sieve having 20 meshes to the linear inch. Tiles (No. 8) made from this mixture and fired as before were considerably stronger than those made from the "New" clay alone, and could be used for roofing purposes in cases where great strength is not essential.

It was thought that the addition of a small quantity of Portland cement to the raw clay might cause a lowering of its fusion point and hence produce a stronger tile on firing. A tile (No. 9) made with 98 per cent. of the ground "New" clay and 2 per cent. of Portland cement, and fired as before, appeared to be somewhat superior to one made from the mixture of the two clays, and could similarly be used for roofing purposes in cases where great strength is not essential.

In connection with the binding qualities of this "New" clay, it may be mentioned that a mineralogical examination at the Imperial Institute showed that it contained no felspar. If deposits of the latter mineral occur in the locality where the clay is found, or if supplies could be obtained cheaply from elsewhere, the effect of adding a small proportion (about 5 per cent.) of finely ground felspar to the raw clay should be tried, as it is possible that such an addition would furnish a mixture having the necessary binding properties.

As the particles of coarse quartz, etc., in the clay are rather numerous, it might prove too expensive to grind the material to the fineness recommended in the foregoing experiments. It was therefore thought desirable also to carry out some trials with clay from which these fragments had been removed by washing, and the following results were obtained.

The washed clay, obtained by the removal of about 32 per cent. of siliceous and ferruginous matter, proved to be very plastic, but was quite suitable for successful working. Tiles (No. 10) made from the washed clay when fired at 1,000° C. for 6 hours were very strong and of good colour, but had a rather high shrinkage which, it was thought, might be reducible by the addition of sand or "grog."

In order to try the effect of leaving some of the finer sand in the clay, the sand previously removed from the clay by washing was sifted through a sieve having 20 meshes to the linear inch, and the portion retained on the sieve was rejected. The material passing through the sieve was added to the washed clay in the proportion of 10 per cent. of sifted sand to 90 per cent. of clay. Tiles (No. 11) made from this mixture when fired as before were strong and hard, but the shrinkage was not reduced to any great extent.

A quantity of "grog" was then prepared by firing the raw clay to a temperature of about 1,100° C. for 6 hours, and grinding the burnt product to pass a 20-mesh sieve. Tiles (No. 12) made from a mixture of 10 per cent. of "grog" and 90 per cent. of washed clay were strong and sound, and had a shrinkage well within the usual permissible limits.

The results of the tests made in the above experiments are tabulated on page 308.

These results indicate that the "New" clay is unsuitable, in its raw state, for the manufacture of tiles, and that fine grinding will not improve it sufficiently to give a good product.

Fairly strong tiles can be made from the ground clay in admixture with a good binding clay (e.g. "Old" Clay), or with a small quantity of Portland cement.

Strong tiles can be made from the washed clay in admixture with suitable quantities of sand or "grog," the latter being the more effective in reducing the somewhat high shrinkage.

Brick-making Tests.—The results obtained in the tile-making tests indicated that this "New" clay differs in character from the "Old" clay, and is a much less

"New" Clay Tiles

Material.	Water added (per cent. of dry clay).	Temperature of firing (maximum)[1]	Duration of firing at maximum temperature.[1]	Shrinkage on air-drying.	Additional shrinkage on firing.	Total shrinkage.	Water absorption.	Ring.	Colour.
			Hours.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*		
No. 6.—Raw New Clay, unground . . .	12·5	1,000° C.	6	4·6	2·6	7·2	16·6	Bad.	Reddish buff mottled with red.
No. 7.—Raw New Clay, ground . . .	19·8	1,000° C.	6	4·7	2·6	7·3	16·6	,,	Reddish-buff.
No. 8.—50 per cent. New Clay, 50 per cent. Old Clay	20·0	1,000° C.	6	6·0	3·4	9·4	15·7	Fairly good	,,
No. 9.—98 per cent. New Clay, 2 per cent. Portland cement . .	19·8	1,000° C.	6	4·5	3·3	7·8	16·5	,,	,,
No. 10.—Washed New Clay. . . .	26·8	1,000° C.	6	6·1	4·3	10·4	17·4	Very good	Light buff.
No. 11.—Washed New Clay + 10 per cent. sand	22·5	1,000° C.	6	5·7	4·1	9·8	18·0	Good	,,
No. 12.—Washed New Clay + 10 per cent. grog	22·5	1,000° C.	6	5·6	1·6	7·2	18·2	,,	,,

[1] *Total period of firing about 24 hours.*

satisfactory material for the manufacture of bricks or tiles. This was verified by making bricks from the raw clay, (*a*) unground (No. 13), (*b*) ground to pass a sieve having 8 meshes to the linear inch (No. 14), and (*c*) ground to pass a sieve having 20 meshes to the linear inch (No. 15).

After firing at 1,000° C. for 5 hours the bricks made from the unground and the coarsely ground clay were weak, and although those made from the more finely ground clay were stronger, they were still brittle and unsatisfactory.

In order to overcome the poor binding properties of this clay, bricks (No. 16) were made of equal parts of "Old" and "New" clay, both clays being ground to pass a sieve having 8 meshes to the linear inch. After firing to 1,000° C. for 5 hours the bricks produced from this mixture were strong, and had a good ring. Their appearance was somewhat marred by small cracks radiating from fragments of quartz. Although such bricks would be quite suitable

for certain uses, it seemed desirable to effect the removal of the quartz, and a further portion of the clay was therefore washed. Bricks (No. 17) were made from 80 parts of this washed clay in admixture with 20 parts of "grog," made from the raw clay previously fired to 1000° C. for 6 hours and ground to pass a sieve of 8 meshes per linear inch. These bricks, after firing under the same conditions as before, showed small superficial cracks, but were strong and had a good ring.

The results of the tests made in the above experiments are tabulated below:

"New" Clay Bricks

Material.	Water added (per cent. of dry clay).	Temperature of firing (maximum).[1]	Duration of firing at maximum temperature.[1]	Shrinkage on air-drying.	Additional shrinkage on firing.	Total shrinkage.	Water absorption.	Ring.	Colour.
			Hours.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*		
No. 13.—Raw New Clay, unground . . .	21·8	1,000° C.	5	5·0	1·0	6·0	—	Bad.	Buff
No. 14.—Raw New Clay, ground (8-mesh sieve) .	21·8	1,000° C.	5	4·8	1·0	5·8	19·0	"	"
No. 15.—Raw New Clay, ground (20-mesh sieve).	21·8	1,000° C.	5	6·0	1·0	7·0	19·2	Fair	"
No. 16.—50 per cent. New Clay, 50 per cent. Old Clay.	21·8	1,000° C.	5	5·0	1·8	6·8	17·7	Good	"
No. 17.—80 per cent. washed New Clay, 20 per cent. grog . .	24·3	1,000° C.	5	5·8	3·8	9·6	18·4	"	"

[1] *Total period of firing about 24 hours.*

These results show that the "New" clay alone is unsuitable in the raw state, either when coarsely or finely ground, for the manufacture of strong building bricks. Bricks suitable for certain purposes can, however, be made from mixtures of equal parts of "Old" and "New" clay, whilst the best results are obtained by using mixtures of the washed "New" clay with suitable quantities of "grog."

TILES

The portions of locally made tiles, burnt and unburnt, which were received at the Imperial Institute appeared to have been made from the "New" clay without subjecting it to any preliminary treatment. The burnt pieces were

only slightly stronger than the unburnt material, and had evidently been insufficiently fired. This was shown by the fact that a portion of a burnt tile, after being dried at 100° C., still suffered a considerable loss (about 5·5 per cent.) on ignition.

In order to determine whether any improvement in strength could be effected by further firing, portions of the burnt and unburnt tiles were refired at the Imperial Institute for about 24 hours, including 6 hours at a temperature of 1,000° C. This treatment caused the material to become much stronger, but the tiles became covered with small cracks, in most cases radiating from particles of quartz or iron oxide on the surface of the tile. Even after this refiring, however, the burnt tiles were still much weaker than ordinary English roofing tiles.

It appeared likely that the faults in the tiles made in Nigeria were partly due to the use of unsuitable material and partly to insufficient firing. The results of the experiments made at the Imperial Institute have shown that the "New" clay is unsatisfactory for use alone as a brick- and tile-making material.

Summary and Conclusions

The results obtained in the present investigation show that the "Old" clay is suitable for the manufacture of bricks, and could be used for this purpose either alone or mixed with grog or with "New" clay. For the production of roofing tiles it would be necessary either to grind the clay, or to wash it, in order to reduce the amount of coarse siliceous matter present.

The "New" clay is lacking in binding properties, and hence if used alone would not make strong bricks, but a satisfactory result could be produced by mixing it with a certain proportion of "Old" clay.

For the manufacture of tiles the "New" clay alone is not satisfactory, but a product of fair quality can be obtained from mixtures of "New" and "Old" clays, or by adding 2 per cent. of Portland cement to the "New" clay. The "New" clay also gives satisfactory tiles if it is washed and mixed with a suitable quantity of "grog."

GENERAL ARTICLES

RECENT AGRICULTURAL DEVELOPMENTS IN THE GOLD COAST

THE following notes on recent progress in the development of copra, Sisal hemp, rice and shea butter in the Gold Coast Colony have been prepared by Lieut.-Col. A. Ogilvy, Deputy Director of Agriculture.

Communal Coconut Plantations.—Along a littoral which extends for some 300 miles there is much land eminently suitable for the cultivation of the coconut palm. At present fishing is the principal industry of the inhabitants of the towns and villages along this stretch of coast. This occupation is one which can conveniently be carried on concurrently with the manufacture of copra, but hitherto the latter has received no attention from the natives, except in a portion of the eastern section, where a small export trade is in existence.

With the object therefore of bringing home to the people the potential wealth that is within their reach, and as an incentive to them to extend the small groups of coconut palms which are found in most of the villages, propaganda of a practical nature was decided upon towards the close of 1920. Steps were taken early in 1921 to establish communal coconut plantations, each of some 300 acres in extent at Attuabo and Abra in the Western and Central Provinces respectively; in the Eastern Province, instead of one large plantation, smaller ones are in process of establishment at four tribal headquarters. The total area of these small plantations, however, will not exceed 300 acres. The lands on which work is now in progress have been loaned by the various Chiefs on behalf of their stools for a period of 15 years, to be extended to 20 years, if necessary.

It is proposed that the Government shall receive the produce until the cost of establishment has been recovered, when the plantations, complete with drying sheds, store houses, etc., for the manufacture of copra, will be handed over to the Chiefs concerned for the benefit of their communities.

It is anticipated that planting (25 ft. × 25 ft.) will be practically complete towards the end of the current year, and that the plantations will be in full bearing about 1935, by which time the outlay should have been nearly, if not entirely, recovered. The estimated cost of establishing the plantations is in the neighbourhood of £25–£30 per acre.

Conjointly with the establishment of these plantations, systematic itinerant work is in progress, on which considerable importance is placed by the Department, and it is encouraging to note that amongst the people a lively interest has been awakened, from which it is hoped good results will accrue. Demonstrations on the preparation of copra are given from time to time at suitable centres, by Ceylon and African experts, as it is only by persistent work of this nature that satisfactory results can be achieved.

Sisal Hemp.—The cultivation of Sisal hemp was commenced in 1920, when an area of 1,000 acres was loaned to Government by the Chief to whose stool the land belongs. The site lies a few miles to the west of Accra and was chosen with the object of demonstrating to the inhabitants that these dry plains at present lying waste can be profitably turned to advantage. Nurseries were formed, serious planting commenced in July 1920, and is now practically complete. The plants are shooting up and showing vigorous and healthy growth; and climatic and other conditions therefore appear to be admirably suited to the crop.

The installation of suitable decorticating machinery is now under consideration, together with the construction of tram lines for the transport of the leaves to the factory.

There are many miles of land suitable for growing Sisal hemp and it is hoped that by the aid of this practical demonstration together with systematic propaganda the native farmer may be induced to take up and extend the cultivation.

Ultimately, after the Government has recovered the cost of establishment, the plantation, complete with machinery and all other accessories, will be handed over to the Chief and his people, for their own benefit.

It is estimated that the cost of producing the fibre

and despatching it to the English market will be in the neighbourhood of £22 per ton.

Rice.—The development of this product is in progress at two centres, viz. Appolonia in the Western Province of the Colony, and Northern Ashanti.

The rice which finds most favour amongst the farmers at the present time is a red variety of the upland type, which shows great lack of uniformity, and gives comparatively low yields.

Small experimental farms have been established at both centres to grade up the quality of the rice, and variety trials with both local and imported types are in progress.

In Northern Ashanti the uncertainty of the rainfall at the critical period of growth and the unsuitability of soil conditions may prove to be limiting factors to much extension. The trials, however, have only extended over two seasons and possibly more promising results may be achieved during the current year.

In Appolonia, on the other hand, rice is the principal crop and the climatic and soil conditions appear to be favourable to its cultivation. The establishment of an experimental station in the district, and the propaganda work which has been undertaken by the Officers of the Agricultural Department, have already created a practical interest amongst the farmers.

The prospects of extending the rice industry are distinctly hopeful and proposals are therefore under consideration to erect a small central hulling factory to encourage the farmers and to reduce hand labour.

As rice is a foodstuff imported in considerable quantities, there is much room for local development.

Shea Butter.—The shea butter tree (*Butyrospermum Parkii*) is found in the Northern Territories distributed in considerable numbers over thousands of square miles. The fat from the seeds (shea butter) is used largely in native cooking and also to some extent by Europeans. The value of the fat, however, so far as the European market is concerned, is somewhat affected by the presence of unsaponifiable matter amounting to approximately 4 per cent. Preliminary work has now been commenced

by the Agricultural Department in co-operation with the Imperial Institute to solve the many problems which present themselves in connection with this product, in preparation for the time when cheaper transport facilities are available.

Recent efforts have been directed towards what may be considered one of the most important of these problems, *i.e.* elimination of the unsaponifiable matter. The chemist of the Agricultural Department has recently completed an extensive survey of the shea butter tree area with the object of studying the native method of fat extraction and subsequent preparation, and many samples of nuts and butter from different areas have been collected for examination.

Steady progress is being made in the collection of data in regard to the distribution of the tree, and its botanical features, as it has yet to be decided whether there is more than one species of shea butter tree in the Northern Territories. The observations so far recorded indicate, however, that probably only one species occurs.

Considerable damage is caused annually by fires which ravage a large part of the area during the dry season. It is natural to expect, therefore, that these fires must materially reduce the yielding capacity of the trees affected, and definite experiments on this point are now in progress. Typical 10-acre plots have been marked off in different parts of the country, half of which have been fire-traced in such a manner as to preclude the possibility of fire affecting the trees.

The following data will be collected and recorded:

(1) Annual girth measurement of 20 trees in each plot.

(2) The weight of nuts collected from all the trees in each plot.

Notes on the following points will also be made:

(*a*) The effect of fire protection in increasing the labour in collecting nuts from the undergrowth of grass and weeds.

(*b*) The time of flowering and ripening of the fruits.

(*c*) The effect of protection in increasing insect pests.

(*d*) Natural regeneration.

If the unsaponifiable matter can be eliminated from the butter, and cheap transport facilities become available, a valuable industry may be established.

In this connection it may be mentioned that the Conservator of Forests, after a tour of inspection of the Northern Territories, has recorded his opinion that the shea trees now existing in the country are capable of producing 260,000 tons of shea butter per annum. Enquiries are being conducted with a view to ascertaining the amount that the available population is capable of producing.

All the products mentioned in the foregoing notes are being developed in areas which are unsuitable for cocoa and oil palms, with the object of affording new and remunerative industries for the natives of those districts.

THE NIPA PALM AS A SOURCE OF SUGAR AND ALCOHOL

THE manufacture of intoxicating beverages from the sugary sap of various species of palm has long been practised by the natives of tropical countries.

Chief among the palms employed for this purpose are the nipa palm (*Nipa fruticans*, Thunb.), the coconut palm (*Cocos nucifera*, Linn.), the buri palm (*Corypha elata*, Roxb.), the sugar palm (*Arenga saccharifera*, Labill.), the sago palm (*Metroxylon Sagu*, Rottb.), the palmyra palm (*Borassus flabellifer*, Linn.), and the date palms (*Phœnix dactylifera*, Linn., and *P. sylvestris*, Roxb.).

The fermented sap of these palms is drunk as "toddy" or under various other names; and in some countries it is distilled to produce spirituous beverages, such as the arrack of India and the Far East. The manufacture of the latter class of product is carried out most notably in the Philippines, where a number of preparations, containing from 10 to 55 per cent. of alcohol and in many cases sweetened with sugar and flavoured with various imported "essences," are put up either under fancy

names or in imitation of well-known brands. Among the most popular of these products are "anisado," "gin," "vino de coco" and "vino de nipa"; the last two are untreated distillates to which no flavouring material is added.

Most of the palms mentioned above occur in the Philippines, but by far the most important there as a source of alcohol is the nipa palm. This has certain practical advantages over other palms, not the least of which is that the sap is drawn from the inflorescence stalk which grows near the ground, thus obviating the necessity for climbing; further, the palm grows on areas which would otherwise be unproductive, and where water transport is easy. Some 2,000,000 proof gallons of alcohol are produced annually in the Philippines from this palm alone, and practically the whole of this is consumed in the form of spirits, mostly by the native population, an insignificant fraction being employed for burning and industrial purposes.

The economic and fiscal possibilities of the nipa palm attracted the attention of the Philippine Government some years ago, and an investigation of the subject was instituted. The data available showed, *inter alia,* that the nipa palm was probably the cheapest source of alcohol in the world. Reports on the subject have been published by the Bureau of Science at Manila from time to time since 1911, and these constitute almost the sole source of scientific information on the subject.

Occurrence and Habits of the Nipa Palm

The nipa palm has an extensive distribution in the Eastern Tropics, being found in the Philippine Islands, the Malay Archipelago, Borneo, Papua, Burma, Lower Bengal, the Andamans, and Ceylon. It is the only species of the genus *Nipa.* Its habitat is river deltas and the land adjacent to tidal rivers which is flooded at each rise of the tide; it will not grow where only fresh water or only salt water can reach it. Subject to these requirements its needs are very few and its propagation is rapid. It is characteristic of the palm that it grows unmixed

with other vegetation over large areas, this being due to its rapid propagation and to the nature of its habitat. Nipa areas frequently consist of dense masses of the palms which are almost impenetrable. There are numerous extensive nipa swamps ("nipales") in the Philippines, the largest continuous area being one of about 44,000 acres in the Provinces of Bulacan and Pampanga; and in Borneo there are even larger areas, including one surveyed stand of 57,000 acres on the delta of the Padas River.

The plant reproduces itself under natural conditions mainly by the growth and branching of its creeping stems. By this means one plant gives rise to others in increasing numbers and over an ever-widening area, any dying off of older plants being more than compensated by the production of fresh ones at the growing ends of the stems.

In the natural state, with the palms growing very close together, flowers are not often formed. When the palms are not excessively crowded, however, they show a greater tendency to produce inflorescences, and since it is from the fruiting stalks that the sap is obtained, it is desirable, where the swamp is to be exploited, that it should be thinned out. Opinions vary as to the most desirable spacing. According to Enrique Zobel (*Estudio de la Planta Nipa*, Manila, 1906), in order to keep a nipal in good condition the plants must be thinned until they are from 1·5 to 1·7 metres, or 5 ft. to 5 ft. 8 in., apart. In places where new plantations are started, a spacing of 6 by 6 ft., or about 1,200 plants to the acre, may perhaps be recommended.

The nipa palm differs from others in that, owing to the creeping habit of the plant, its flowering shoot grows close to the ground, a very important feature from the point of view of accessibility for tapping, to which reference has already been made.

The leaves are pinnate, 7 yds. and upwards in length, and occur in erect clusters. The fruit clusters are globose, some 12 in. in diameter, the individual fruits being flat, about 5 in. long and 4 in. broad.

The flowering season is rather indefinite; in the provinces of Bulacan and Pampanga the palm is stated to

flower usually in February and March. It takes some four months for the fruit to ripen. A nipa plant may produce small fruits when it is four years old, but the palm does not attain its full size for about ten years. Tapping for sap is commonly begun in the fifth year. The length of time during which a plant will continue productive has not been determined, but a cautious estimate places the period at " perhaps 50 years or more."

A nipa plant does not produce an inflorescence each year. Even under favourable conditions, only a certain proportion, probably as a rule less than one-half, of the plants in a nipal will be productive in any particular season. Estimates on this point vary considerably, but according to investigations in the Philippines, cultivated swamps may contain, on a conservative estimate, 800 to 1,000 trees per acre, of which 300 may be depended on to produce inflorescences in any one year.

Collection of the Sap

The following account of the collection of the sap, as well as the description of the production of alcohol and sugar in succeeding paragraphs, relate to methods practised in the Philippines.

Tapping is commenced soon after the fruit begins to develop. The stalk is cut straight across immediately below the fruit cluster, which is thrown away, and the flow of sap (" tuba ") from the wounded surface starts at once. If a plant bears two fruiting stalks, the usual practice is to tap one only, the other being cut down and the wound allowed to dry. It is a native custom to kick each fruiting stalk at intervals of from two to seven days for some weeks before it is cut, in the belief that this improves the flow of sap. There appears to be reason to suppose that the treatment does actually have a beneficial effect, and in any case it has the result of bending the stalk, thus facilitating the collection of the juice.

The native method of collecting the sap is by means of bamboo stems. A bamboo joint (" tuquil " or " bombon ") is fixed to the cut end of the stalk, the latter being inserted through a hole cut in the side of the tuquil, in

which the sap collects. The capacity of a tuquil is commonly about three or four pints.

Each day the tapping is repeated; that is to say, a thin slice is shaved off the cut end of the stalk, to remove the clogged-up portion and expose a fresh surface, thus facilitating the flow. A stalk continues to yield sap for a limited period, usually between two and three months. As the plants in any particular area do not reach the tapping stage simultaneously, the collecting season extends over a period of six or seven months. The season commonly starts about July or August, but the date is somewhat indefinite, depending on weather and other conditions. The daily collections reach a maximum about the end of the second month, thereafter showing a steady diminution. It is important to use care in tapping; otherwise it is not uncommon for stalks to be pared down to the ground considerably before their flow has ceased.

In certain localities tapping is started before the fruit begins to develop. This is said to have the effect of approximately doubling the rate of flow and halving its duration.

The tuquils are emptied into earthen jars, which are conveyed to the distilleries in small canoes ("bancas"), each hewn out of a single log; sometimes the tuba is emptied direct into the boats. Generally there is a natural network of waterways along which the boats can be paddled, but in some cases artificial courses have been constructed. In certain districts there are waterways which are impassable at low tide, and the time of day at which the sap is collected is therefore determined by the tide. It has been proposed that pipe lines should be laid down to convey the tuba from the nipales to the distilleries. This would not only save time spent in paddling the canoes to and from the distilleries, but would also remove some of the causes tending to the deterioration of the sap.

Yield of Tuba

The quantity of tuba obtainable from one nipa stalk cannot be stated with precision. Recorded statements on the subject differ very widely, and such actual determinations as have been made are based on observations

of only a small number of plants. Moreover, the yield probably varies from season to season. Such information as is available indicates that on an average the daily flow from one stalk is about one pint, its total yield during the period of flow being about 9 or 10 gallons. Accepting the lower figure, and assuming (cf. page 318) that 300 plants per acre are tapped each season, the annual yield of tuba may be taken at 2,700 gallons per acre.

Production of Alcohol from Tuba

Nipa sap contains on an average 15 per cent. of sugar. This consists practically entirely of sucrose or "cane sugar." Sucrose under certain conditions undergoes a change by which it is converted into a mixture of two other substances which are chemically classed as "reducing sugars," the mixture being commonly referred to as "invert sugar." Invert sugar, under the influence of certain organic ferments or enzymes, undergoes fermentation, producing alcohol.

The production of either sugar or alcohol from the nipa palm would thus appear to be a comparatively simple matter. In practice, however, there are certain difficulties. As the sap is ordinarily collected, inversion of the sugar begins at once, and by the time the product reaches the distillery this process is usually complete and alcoholic fermentation is proceeding actively; further, acetic acid fermentation is not infrequently commencing. The inversion of the sucrose and the alcoholic fermentation are unobjectionable if alcohol is to be made, but the acetic acid fermentation entails a loss of alcohol and a deterioration of the quality of the product. It has been estimated that the total loss of alcohol during the period between the collection of the sap and the time that the product leaves the distillery is in some cases as high as 50 per cent. This is mainly due to the crude and wasteful methods employed by the natives and to their primitive ideas as to the conduct of biochemical operations. The loss could be greatly reduced by the adoption of a higher standard of cleanliness coupled with an elementary knowledge of the processes involved; indeed, a considerable improvement has already been effected by the authorities

in the Philippines, and the crude stills formerly used have now been largely replaced by modern distilleries. Some 75 such distilleries were operating before the war.

The question of the yield of alcohol obtainable from nipa sap is discussed in the reports of the Manila Bureau of Science. The recorded data of 33 distilleries in the Philippines for the fiscal year 1910 showed an average yield of 5·6 per cent. of alcohol, by volume, calculated on the tuba, and the opinion has been expressed that under more satisfactory working conditions a yield of 6 to 7 per cent. should be obtainable. On the basis of the production of tuba mentioned above this would mean a yield of about 170 to 200 gallons of 95 per cent. alcohol per acre.

Production of Sugar from Tuba

If sugar is to be manufactured from the tuba, it is necessary to prevent the destructive processes which, as already mentioned, begin under ordinary conditions as soon as the sap leaves the plant. These changes are encouraged by dirty conditions of working, but the adoption of cleaner methods is not alone sufficient to prevent a loss of sugar, since the agents initiating the changes are present in the sap itself. Research in the Philippines has shown that the sap contains a zymogen which under the influence of the air gives rise to an enzyme (invertase) causing inversion of the sucrose. There has also been found in the sap an enzyme of the peroxidase type which brings about chemical changes involving loss of sugar. This latter enzyme would appear to be present chiefly towards the end of the period of flow from any particular stalk.

The best methods of combating these destructive agencies have been the subject of investigation in the Philippines. It has been found that the action of the invertase enzyme is stopped in the presence of alkalis, and that the addition of a little lime cream to a tuquil will prevent the inversion of the sugar. The peroxidase enzyme is however capable of working in alkaline solution, and it is necessary to employ other agents for its destruction. For this purpose a sulphite has been found to

be effective. This may be added in the form of sodium sulphite, or more conveniently as calcium sulphite, formed by leading sulphur dioxide into the lime cream before using it. Incidentally, this addition has the advantage of obviating the necessity for bleaching at a later stage.

To obtain the full benefit of such treatment it is not sufficient merely to place the lime cream in the tuquil and collect the sap in the ordinary way. If this is done it is only the first portions of the sap trickling down the sides of the tuquil that come into proper contact with the lime, the upper layers being free from its action. This difficulty has been overcome by the use of a small funnel whereby the sap is led to the bottom of the tuquil; every portion of sap thus comes into contact with the lime, the effect of which extends throughout the whole of the contents of the tuquil. It is stated that with such an arrangement the amount of lime required probably does not exceed 1 per cent. of the tuba.

In order to ensure the highest degree of practical efficiency from the method, some attention has been devoted to the details of adjustment. An improved arrangement is described as follows by A. H. Wells and G. A. Perkins in the course of a paper on " Recent Improvements in Nipa-sugar Manufacture " (*Philippine Journal of Science*, 1922, **20**, 45): " The new type of tuquil is not pierced with a hole for the stalk, but is suspended by means of a piece of ordinary telegraph or heavy fence wire. Under the stalk, near the end, a small bib of galvanised iron catches all the tuba and drops it into the funnel. The wire is firmly held to the stalk by a wood or bamboo wedge placed between the upper loops of the wire and the stalk." In case this method of keeping the arrangement in position is found too troublesome, the authors add: " the simplest method is to make a small hole in the tuquil, which fits so tightly on the stalk that no fastening is required."

It is not proposed to discuss here the technology of the manufacture of refined sugar from nipa sap, as it does not differ essentially from cane sugar practice (*cf.* this BULLETIN, 1921, **19**, 54), but reference may be made to one technical point. In the manufacture of palm sugars

generally, difficulty has been experienced in the past owing to trouble in precipitating albuminoid substances present in the sap. It is claimed that this difficulty is overcome by the Hines process. This process was briefly described as follows in a paper presented by O. W. Barrett to the Third International Congress of Tropical Agriculture held at the Imperial Institute in 1914 (*Transactions of the Congress*, vol. ii, page 590):

"The juice is heated nearly but not quite to the boiling-point and then allowed to cool. The albuminoid substances, coagulated by the heat, fall within a few minutes as a whitish layer at the bottom of the receptacle; the clear sap is decanted off and the residue treated in a similar manner to sugar-cane precipitates. A small amount of milk of lime is then stirred into the still warm sap, and this is carbonated by blowing into it a current of gas (filtered to remove soot, etc.) from the chimney, or, if limestone is at hand, a very small furnace would furnish a flow of high-grade gas. The second precipitate, consisting largely of the pectins, gums, etc. (which, if boiled with the sucrose cause discoloration of the finished product), are either allowed to settle or are strained out. Boiling then proceeds in the regular manner, and a fine-flavoured product, fully as white as that obtainable in the ordinary cane-sugar factory, is produced."

As already stated, nipa sap contains on an average 15 per cent. of sugar. It is estimated that under practical working conditions 100 gallons of sap should yield about 115 lb. of sugar of 99–99·5 per cent. purity. The production of sugar should therefore be about 3,105 lb., or roughly 28 cwts., per acre.

Nipa Palm in the British Empire

The chief British possession in which the nipa palm occurs over extensive areas is British North Borneo. The question of utilising the plant to the best advantage in that country is occupying the attention of the authorities, but up to the present there has been little systematic attempt to develop an industry. In Malaya also there are possibilities which hardly seem yet to have been fully explored.

In India the plant would appear to be chiefly known as yielding material for thatching, braiding, and matting. There is a considerable trade in nipa (" golpatta ") leaves in the Sundarbans. The only reference to the plant as yielding sugar or alcohol in Watt's *Commercial Products of India* is a statement that " toddy is obtained from the spathe (as Linschoten observed in 1598)."

In Nigeria a plot of nipa was started at the Calabar Experiment Station in 1906, and the leaves have been used locally for thatching.

In Papua proposals have been made to utilise the nipa palm as a source of paper pulp, but the matter does not appear to have been further pursued. Samples of nipa palm petioles and fibre from the Federated Malay States, and of nipa leaves from Sarawak, have been examined as paper-making materials at the Imperial Institute, but the results did not appear to indicate that the plant would be likely to become a serious competitor with other sources of raw material for the world's supplies of paper (cf. this BULLETIN, 1912, **10**, 376; 1914, **12**, 42).

An investigation of the palm as a source of tanning material is reported in " Tanstuffs of the Sundarbans Forest Division " (1920), by J. A. Pilgrim, Tannin Expert to the Government of India. The leaflets of the fronds when dried and crushed gave a powder, showing 10·26 per cent. of tannin, which produced a very pale, almost white, leather. No part of the plant contained more tannin than non-tannins, and it therefore could not be regarded as a satisfactory material for the manufacture of tannin extract.

It is clearly as a source of alcohol and sugar that the nipa palm is economically most valuable. Whether it should be introduced into countries where it does not now exist is a matter for local consideration, but there would appear to be little doubt that its extended utilisation should be encouraged in those areas in which it already occurs.

The question whether the nipa palm is most valuable as a source of sugar or alcohol depends on economic and other conditions which are subject to variation. The increasing demand for alcohol as a substitute for petrol

for power purposes, particularly in tropical countries, renders the nipa palm of importance as a possible source of supply of motor spirit; whilst considered as a raw material for sugar, the palm could probably compete advantageously in many countries with other available materials.

DATE GROWING IN MESOPOTAMIA

THE cultivation of dates is the most important industry in Mesopotamia ('Iraq). The greater part of the produce is consumed locally, but large quantities are exported to the United Kingdom, India, the United States, Arabia, Persia and other countries, the total value of such exports amounting in 1919 to about two and a half million pounds sterling. In view of the importance of the industry to the country, the Department of Agriculture, since its formation in 1917, has paid considerable attention to the palm, and has recently published two Memoirs (Nos. 3 and 6) on the subject. Of *Memoir* No. 3, "Dates and Date Cultivation of the 'Iraq," by V. H. W. Dowson, two parts have been issued: Part I dealing with the Cultivation of the Date Palm on the Shat Al 'Arab, and Part II with the Results of an Investigation into the Yield of Date Palms on the Shat Al 'Arab (Cambridge: W. Heffer and Sons, Ltd., 1921, price 10*s*. and 5*s*. respectively). A third part will describe the varieties of dates and date palms to be found on the Shat Al 'Arab. *Memoir* No. 6, deals with the Pests of the Date Palm in the 'Iraq (Department of Agriculture, Baghdad, 1921, price Re. 1).

Distribution.—The date palm flourishes in the 'Iraq wherever it is watered and tended, from Ana on the Euphrates and Samara on the Tigris, southwards. Nearly all towns in the 'Iraq are surrounded by date groves, and on the Euphrates they are common in regions where there are no towns. The most important area of date cultivation, however, and indeed the largest single area devoted to the palm in the world, is that bordering the Shat Al 'Arab from Fao on the Persian Gulf to Qarna, a distance of 108 miles. Altogether there are about 138,000

acres of date palms in this region, of which about 111,000 acres are in 'Iraq, the remainder, for a distance of 42 miles on the left bank of the river, being in Persian territory. The next largest centre of date cultivation is Baghdad, which lies amongst 20 miles of date gardens lining both banks of the Tigris. Other important areas, arranged roughly in order of importance, are: (1) Shithatha and Rahalia oases, (2) Husainia Canal, (3) Middle Euphrates towns, (4) Lower Euphrates towns, (5) Ramadi, Hit, Haditha, Ana, (6) Boqooba, Mendali, Badra, (7) Amara.

Soil.—The soil on which the date palm is grown varies greatly in character, good results being obtained on river silt and desert sand; but the finest dates are produced close to the limestone hills in the neighbourhood of Badra and Mendali, 70 to 100 miles north-east and east of Baghdad. The least favourable soils are those which are water-logged or too dry, but the palms will withstand even these adverse conditions for many years.

Cultivation.—Generally speaking, the date gardens of the 'Iraq are well cultivated, and only in some of the smaller groups of gardens on the Euphrates and the Tigris are they left many years without cultivation. In the best gardens on the Shat Al 'Arab a quarter of the ground is dug to a depth of 4 ft. each year, the remainder being given a shallow digging. Round Baghdad and in other important date-growing areas, the cultivation is thorough, but not so deep, ploughing being practised in some places. With the exception of gardens on the right bank of the Shat Al 'Arab and of those round Baghdad, very few gardens in the 'Iraq are manured. The manure is chiefly bazaar sweepings of poor quality, moderately good manure being very expensive.

Vegetables, fruits (citron, orange, apple, fig, etc.), gourds, pulses, cereals and other subsidiary crops are frequently grown in the date gardens, the kind depending on the spacing of the palms and the degree of cultivation given to the soil. Where the ground is not tilled, the garden is sometimes let for sheep grazing.

Irrigation.—In order to obtain the best crops it is necessary to irrigate the land, as the roots must be kept supplied plentifully with water, particularly during the

hotter parts of the year. This is effected on the Shat Al 'Arab by tidal inundation, the fresh water which is banked up in the river twice a day by the action of the tides in the Persian Gulf flowing into the numerous creeks and channels which intersect the whole date belt. During spring tides the irrigation water near Fao, at the mouth of the river, is often salt, but the palms do not appear to be adversely affected, the date in fact being more tolerant of salt than any other crop cultivated in the 'Iraq. In some parts, such as on the Middle Euphrates, the channels are filled from the rivers by gravitation, at least during part of the year, but where flow water is not available the water has to be lifted from the river or wells. This is done in various ways, either by a primitive water hoist, known as a "dalia," consisting of a bucket fixed at one end of a long pivoted bar, by a "charad," similar to the "dalia" but larger and worked by animal power, by water-wheels of different forms or by a centrifugal pump worked by an oil-engine. The last-named, although expensive, is the most effective and is commonly employed in Baghdad and in Amara.

Pruning.—Pruning is practised regularly, the dead and dying outer fronds being cut off each year about a foot from the trunk, the woody leaf-bases being removed when the palms are about 14 years old.

Propagation.—The date is always propagated by suckers, which are removed from the parent palm when about 4 years old, and are planted either between old palms which they will eventually replace, or in hitherto unplanted land. They are set out regularly in rows, usually about 7 yards apart (125 to the acre), but some garden owners consider that a higher yield is obtained when the palms are planted 8 yards apart (80 to the acre). In the Baghdad area and elsewhere, where the orange is frequently interplanted with the date, the spacing is naturally greater.

Pests.—No parasitic fungus has yet been recorded as harming the date palm in the 'Iraq, but several other pests attack the tree, some of which cause serious loss. The most harmful appears to be a small mite, *Olygonychus* sp., which lacerates the surface of the half-grown fruits

and sucks the juice which exudes, so that the fruits become dwarfed and never reach maturity. This pest is found all over the 'Iraq, particularly in the drier parts. The grub of a beetle, *Pseudophilus testaceus*, causes damage by boring into the leaf-base and eventually into the trunk. It reduces the vitality of the palm and so diminishes the crop, whilst in the case of severe attack the tree is so weakened that it is liable to succumb to high winds. A species of rhinoceros beetle, *Oryctes elegans*, also attacks the leaf-bases and trunk, whilst various scale insects and a plant louse have been found to occur, but do not appear to cause serious damage. A disease, known as "hashaf," in which the young fruits dry up, turn red and drop off, was at first thought to be caused by the caterpillar of a small moth, *Batrachedra amydraula*, which was found in many of such fruits. Later observations, however, seem to show that this shedding of fruits is due to physiological causes, and might possibly be prevented by cultural methods, such as effective pollination and increasing the supply of water and food.

Pollination and Ripening of the Fruit.—As the male and female flowers are produced on different palms and the wind is not to be relied on to effect pollination, the date is invariably pollinated by hand, usually during the month of April. The male inflorescences are cut off before the covering spathe opens and are left in a basket for a day or two for the pollen to ripen. A sprig of the male inflorescence is then placed firmly in the middle of a female inflorescence, or sometimes the pollen is put into a muslin bag tied to the end of a stick and dusted on to the female flowers.

Four different stages of ripening are recognised in the 'Iraq, at which the dates are known respectively as "chimri," "khalal," "ratab" and "tamar." The first-mentioned is small, more or less spherical, hard, green, and in almost all varieties bitter and unfit for food. The "khalal" is of the same shape as the mature fruit, but the skin is not wrinkled and is of a yellow or red colour or yellow with red spots, according to the variety. Dates of some varieties are sweet and juicy at this stage and are esteemed a delicacy amongst the Arabs. The "ratab"

stage is reached when the apex of the fruit becomes soft and moist; the skin is usually translucent and wrinkled. All dates at this stage are edible, but most varieties are allowed to mature fully, as the " ratab " does not travel well and is therefore not easily marketed. Certain varieties, however, are generally eaten at this stage, as the flavour is then considered to be at its best, and the total crop of these is so small that it can readily be disposed of locally. The " tamar " is the fully mature date, such as is exported to the United Kingdom.

Harvesting.—Harvesting takes place mainly in September, although some kinds are ready for gathering at the end of July, whilst others are not ripe until the middle of October. As a rule the fruits ripen fairly evenly. Those which happen to mature before the majority generally fall to the ground and are gathered by children. The finest kinds are picked singly from the bunch as they become " ratab," but the ordinary crop is gathered by cutting the bunches, which are allowed to fall on a reed mat laid under the palm. The dates are then placed in heaps, ready for packing or for transport to central packing stations.

Varieties.—Although a very large number of varieties of date palm occur in the 'Iraq, only four main kinds are exported from Basra, viz. " Istaamran " or " Sayers," " Halawi," "Khadhrawi " and " Zahidi." This is due partly to the fact that the choicest varieties are not sold, but are eaten by the garden-owner and his family, and partly to the less common kinds, not of outstanding merit, being mixed with the main crop of the commoner varieties, as the small lots of fruit of such varieties are not worth the trouble of marketing separately. Of the four varieties mentioned above, the most common on the Shat Al 'Arab are " Istaamran " and " Halawi." The latter and " Khadhrawi " are good dessert dates ; " Istaamran " comes next in quality, whilst " Zahidi " is the poorest. The last-named, however, gives the largest yield, the average weight of " tamar " (*i.e.* mature) dates being 126 lb. per palm per year. The average yields from " Halawi," " Istaamran " and " Khadhrawi " are 44, 37 and 30 lb. respectively. The average total yield of " tamar " dates per acre on

the Shat Al 'Arab in 1919 is calculated at 4,920 lb. The exports of the four main varieties from Basra in 1917 were: "Istaamran" 36,000 tons, "Halawi" 25,000 tons, "Khadhrawi" 15,000 tons, "Zahidi" 4,000 tons.

Packing.—The method of packing depends to a large extent on the kind of date. In the case of one or two varieties, fruits in the "khalal" stage are boiled and dried and put up in sacks for sale in the 'Iraq and in Northern India. The cheaper varieties of dates, which are sent to India, Arabia and Persia, are usually packed in palm-leaf baskets, but most of those which leave the Middle Euphrates and Baghdad for the central and northern parts of Arabia are packed in sheep and goat skins. Small quantities of the finest dates are put up in 1 lb. cartons or in wooden boxes containing about 10 lb., but most of the dates exported from Basra are packed in wooden boxes containing 68 lb. net. The dates are placed one by one in layers in the box, each layer being pressed down by means of a stout board on which a man stands.

Composition of 'Iraq Dates.—Dates of the "Halawi," "Khadhrawi" and "Istaamran" varieties have been examined recently at the Imperial Institute. They were found to consist of:

	"Halawi." *Per cent.*	"Khadhrawi." *Per cent.*	"Istaamran." *Per cent.*
Flesh	85·9	90·5	86·7
Stones	14·1	9·5	13·3

The flesh was analysed with the following results:

	"Halawi." *Per cent.*	"Khadhrawi." *Per cent.*	"Istaamran." *Per cent.*
Moisture	19·2	18·7	18·9
Invert sugar	58·0	59·8	59·3

No sucrose was present.

The sugar of date fruits in general has been found to consist chiefly or entirely of invert sugar. The amount present in the flesh of the fruit varies between wide limits, viz. from 28 to 66 per cent., but on the average is 54 per cent. (the average quantity of moisture present being 20 per cent.). The results of the examination of the 'Iraq dates agree well with the latter figures.

THE KAURI-GUM INDUSTRY OF NEW ZEALAND

KAURI-GUM is a resinous product derived from *Agathis australis*, a tall tree which is indigenous to New Zealand, often reaching 200 ft. in height. Two forms of this gum are generally met with in commerce, the fossil gum which is dug from the ground and the recent gum, obtained by "bleeding" or tapping the living tree. Kauri-gum, which is used chiefly in the manufacture of varnish and linoleum, is one of the principal articles of export from New Zealand.

In 1914 a Commission was appointed by the Governor of the Dominion to inspect and classify the kauri-gum reserves in the Auckland Land District, and the report of this Commission forms the subject of a note in a previous number of this BULLETIN (1915, **13**, 139). The kauri-gum industry of New Zealand experienced in the latter half of 1914 a bad period of over-production, caused by the war. Steps were then taken by the Dominion Government to foster the industry and to assist the gum producers by making them monetary grants, advanced on their stocks. Further steps were taken by the Government in 1921 to develop the industry, when the Governor appointed another Commission, whose duties were to enquire into and report on the industry. The findings of this Commission are incorporated in the official report (*Kauri-gum Industry, New Zealand*, 1921).

Kauri-gum is found in the part of New Zealand lying between latitudes 34° and 38° S., a region comprising all that area of the North Island to the north of a line drawn approximately from Kawhia on the west coast to Tauranga on the east. In the early days when only large pieces were exported, the gum was obtained by digging with spades, in those places where it was on or near the surface of the ground and therefore easily obtained. Later on, the gum was dug from deeper ground and from swampy areas, after it had been located by means of the gum-spear, which is a steel rod from 4 to 16 ft. in length and gradually tapering to a blunt point. A few inches from the point, and then at intervals of about $2\frac{1}{2}$ ft. up

the spear, are coils of fine wire, each coil covering about ¾ in. of the spear. This device facilitates the penetration of the spear into the ground. In the course of time, as prices increased, it became profitable to recover the smaller pieces, which had previously been neglected, while at the present day the aim is to recover all the gum that the land contains, even down to the finest particles.

With the object of recovering the fine particles of gum, various pieces of apparatus have been devised. A primitive form consists of a galvanised iron tub with a perforated bottom and fitted with a paddle, revolving by hand on a central shaft. Gum-bearing soil, puddled with water, is stirred in the tub in order to break up the soil, and then passes through the perforated bottom. The material left in the tub, consisting of gum particles, woody and fibrous material, sand and unpulverised earthy matter, is removed and dried in the open air. When dry, it is hand-winnowed, whereby much of the woody and fibrous material is eliminated. By this method a considerable portion of the fine gum is lost and a large amount of foreign matter retained. Subsequently, a more elaborate apparatus of the same type came into use. This consists of a larger tub, fitted with fine sieves of various meshes instead of the perforated bottom. Steel agitators rotating on a central shaft are driven by a small engine while a continuous supply of water flows through the tub. The material retained on the sieves is treated as above, though in a few cases a winnowing machine is employed to remove the woody material. A larger and improved type of apparatus which is designed for the recovery of gum from swamp material by a continuous process is in operation in two localities. By this method the swamp material, after being mixed with water, is raised by a spiral tube elevator from a sump in which the material is originally placed. To the lower end of the tube elevator beaters are attached whereby the material in the sump is kept stirred. After being elevated, the gum-bearing material passes into a chain disintegrator where the soil is broken up without unduly crushing the gum. The material then travels into a series of three horizontal cylindrical screens of diminishing mesh. All the material

retained by the screens and which will pass through a seven-eighths inch mesh, after being dried in the air, is put through a large winnowing machine, provided with screens which divide the product into different sizes, consisting of nuts, chips, seeds and dust. Trials have shown that by means of this machine a smaller amount of gum is lost in the tailings than by any other machine in use. A smaller portable form of the machine, suitable for use by two or more men, has also been devised.

Another process of recovering gum from swamp material is in operation at Poroporo, where a large steam plant has been erected capable of rapidly treating large quantities of material. The swamp material is sluiced into a sump by a head of sea-water, pumped up from the harbour, and is then raised by a hydraulic elevator and passed through a series of three concentric cylindrical screens of diminishing mesh. Attempts have also been made to obtain the gum by means of a dredging plant, but up to the present this method has not been a commercial success.

The gum recovered by any of these processes still contains a large amount of foreign matter, and of the methods in use for removing this impurity that devised by Maclaurin is the most efficient and practical. This method has been operated successfully on an industrial scale for over two years at the Government kauri-gum store in Auckland. The crude gum is introduced into a cone-shaped tank together with a strong solution of salt (specific gravity 30° Tw.). The contents of the tank are agitated and the air pumped out. On stopping the agitation the gum rises to the surface of the brine, and the dirt, etc., sinks to the bottom of the tank. The dirt and the gum are easily separated by running off the solution with the dirt in suspension into one tank and the upper portion of the solution with the gum into another. The brine solution is recovered by filtration from both solutions, and the gum is well washed to remove all traces of salt and finally dried.

The larger pieces of gum as dug up are covered with dirt and incrustations of "weathered" gum. They are usually washed by the digger and the pieces of the harder

and more valuable sorts are further cleaned by scraping by hand. This treatment is slow, costly, wasteful and only suitable for the larger pieces of hard gum. A process for cleaning gum by means of a sand blast has been patented; an experimental plant equipped in Auckland proved successful and a factory was afterwards erected in Dargaville to clean gum for the market. It is claimed for this method that the gum can be satisfactorily cleaned at a comparatively low cost.

An appreciable amount of kauri-gum is obtained from the living tree by "bleeding" or tapping. Formerly indiscriminate hacking and bleeding were carried on, whereby much injury was done to the trees, until the damage became so great that the State prohibited this practice in their forests; it still continues, however, in some of the privately owned forests. "Bleeding" in recent years has been conducted on fairly systematic lines and under some sort of control. The method of tapping as carried out at present is as follows: V-shaped cuts are made in the bark, horizontally across the trunk. The cut, or "tap," is deepest at the apex where it almost reaches the sap-wood. Taps are cut horizontally round the branches and trunk, 18 in. apart, the interval between the rings of taps being 6 ft. After tapping, the trees are left for six months, when the gum that has exuded is collected and the trees are retapped. Some forests are leased for bleeding shortly before being cut down, the stipulation being made that no taps are made in the trunks of the trees, whilst others are leased without any restrictions, when the trees are tapped from head to foot.

Kauri-gum, after it has been cleaned, scraped or separated from dirt, is graded and packed for export. Size, colour, hardness and purity are the chief characteristics according to which the gum should be graded. The size varies from "bold," several inches in diameter, through many sizes to fine dust; the colour may be any shade between very pale amber and black; the hardness varies from that of the best "dial" gum to that of the chalky gum from the swamps, while the purity lies between that of rescraped "dial" gum containing no

impurity and that of chips and dust containing up to 75 per cent. or more of foreign matter.

Some of the grades exported are uniform and cannot be subdivided into grades of widely differing characters, while many grades are in reality mixed grades, the gum not having been completely separated into uniform portions. The methods of grading are at present rather crude and are based primarily on the division into several main classes, depending partly upon colour and partly on origin, viz. white gum, black gum, swamp gum and bush gum. These main classes are then divided into sub-classes depending on size, colour, cleanness and hardness. Each of these sub-classes is further divided into various grades.

As mentioned earlier, kauri-gum is used chiefly in the manufacture of varnish and linoleum and to a smaller extent for paint. The use for linoleum has developed during the last twenty years, and it is estimated that about 60 per cent. (chiefly low-grade gum) of the total exported is employed in this way.

The average quantity of kauri-gum exported per annum for the last ten years is 5,386 tons, valued at £340,257, equivalent to an average price of £63 per ton. For the year ending March 31st, 1921, the quantities exported to various countries were :

Country to which exported.	Quantity. *tons.*	Value. £
United States of America	3,224	345,992
United Kingdom	2,544	149,422
Canada	314	24,481
Australia	49	4,802
Japan	—	4
Total	6,131	£524,701

The average price during that year was £85 11*s.* 7*d.* per ton.

The export trade in this article from New Zealand is in the hand of twelve regular exporters, the bulk being in the hands of six firms. Each exporter grades and packs the gum according to the buyers' requirements, most of the gum being sold against samples.

Kauri Peat.—In the gum-fields of the North Island there are considerable areas of kauri peat swamps. Kauri peat

differs from true peat both in respect of its origin and its nature. It is the remains of former kauri forests and is associated with large roots, trunks and branches. It yields on destructive distillation a greater proportion of oils than any other peat used commercially; only a small percentage of the oils obtained, however, are derived from the gum contained in the peat.

Various companies have tried during the past twenty-five years to treat kauri peat on a commercial scale for the recovery of the oils, but up to the present no practical results have been obtained in the direction of establishing an industry. Experimental trials have shown that from the black peat that overlies the kauri peat a yield of 20 to 30 gallons of crude oil was obtainable per ton of air-dried peat, and from kauri peat a yield of 40 gallons. Other products obtained included gas, ammonia, acetic acid and charcoal. The crude oil from the kauri peat yielded on fractional distillation 10 per cent. of oil suitable for motor spirit, 80 per cent. of heavier oils and 10 per cent. of pitch. One of the coastal vessels was successfully run on a trip of 170 miles when crude oil obtained by the distillation of kauri peat was used as the fuel for the two 60-h.p. Beardmore engines. Briquettes have been made of the by-products of the distillation and have given excellent results, it being found that they give a good heat, burn steadily, hold fire well, and ignite more readily than coal.

Efforts have been made to utilise the timber which occurs in these peat swamps, and it is suggested that it might possibly be used for fencing and building purposes. This timber when destructively distilled on a small scale yielded 50 to 60 gallons of crude oil per ton of dry wood, which on fractional distillation gave 13 per cent. of an oil suitable for motor spirit and 70 to 80 per cent. of heavier oils.

Among the recommendations of the Commission are the following: That it is advisable that there should be a standard grading of kauri-gum for export and that a Government grader should be appointed, but that at present there should be no interference with the particular

grades put up by merchants; that the methods of recovering the gum from the gum-bearing soils should be improved by lessening the cost of digging and handling the material before treatment and by the introduction of more efficient methods of separating the gum from the dirt and foreign matter usually associated with it, by the general use of small washing plants and of the Maclaurin process (see p. 333) or other equally efficient process for the separation of impurity. Various alterations in the regulations for licences and the imposition of a tax on all gum exported and of a royalty on all gum obtained from Crown lands are suggested. It is also considered advisable that further scientific investigations should be carried out on the effect of "bleeding" the trees and in connection with kauri-gum, peat and all other products of the kauri forests.

MINERAL RESOURCES OF NORTHERN RHODESIA

THE territory north of the Zambesi River, known as Northern Rhodesia, comprises an area of about 291,000 sq. miles. Lack of adequate railways and other means of communication has tended to isolate much of this vast country, and its mineral resources are, therefore, comparatively unknown. The territory is traversed by one line of railway only, which passes through Livingstone, the capital, via Broken Hill and Bwana M'Kubwa to Katanga in the Belgian Congo. This railway is connected with Beira on the coast, via Bulawayo and Salisbury, the distance from Livingstone being about 1,000 miles. It serves a belt of country roughly in the centre of the territory, and the best-known mineral deposits are contained in this belt, being found from 50 to 100 miles on each side of the railway. The mineral possibilities of the remainder of the territory, and particularly of the more remote north-west portion, are practically unexplored, and are likely to remain so until better transport and travel facilities make it more accessible. So far, deposits of the following metals or minerals have been found in commercial quantities in Northern Rhodesia: gold, silver, copper, lead, zinc, bismuth, vanadium, mica

and coal. The relative importance of these deposits may be roughly judged from the following table of total outputs up to the end of 1921 :

	Quantity.	Value.
		£
Gold	12,336 oz.	53,546
Silver	53,592 „	7,491
Lead	67,316 tons	1,527,815
Copper concentrate	5,232 „	220,959
Copper (finished)	7,154 „	378,510
Bismuth	6·2 „	3,491
Mica	1·2 „	412
Zinc ore	13,176 „	85,198
Vanadium ore	61·8 „	2,401
Total value		£2,279,823

The following are the outputs and their values for the year 1921 :

	Quantity.	Value.
		£
Gold	1,383 oz.	7,071
Silver	8,373 „	3,002
Lead	20,318 tons	702,955
Copper	206·3 „	29,615
Vanadium ore	61·8 „	2,401
Zinc	19·3 „	621

The geology of Northern Rhodesia has not been worked out in detail. The information available, which is quite general in character, is chiefly contained in papers by F. E. Studt (see references below). According to this authority, over the greater portion of the country sedimentary rocks are exposed, which to a large extent have been metamorphosed. These are represented by rocks of the Swazi System of Archæan age ; the Transvaal System of Silurian age ; the Waterberg System of Devonian and Devono-Carboniferous age ; and the Karroo System of Permo-Carboniferous age. Studt shows that these four systems are also developed in the adjoining richly mineralised region of Katanga in the Belgian Congo, and that, in fact, these two territories form part of the same geological region. In considering Northern Rhodesia's mineral prospects this fact is significant. The copper deposits of both territories are confined entirely to rocks of the Transvaal system ; whilst the tin deposits of both Katanga and Northern Rhodesia are found in the Nzilo rocks of the Swazi system.

Copper.—The existence of copper deposits in Northern Rhodesia has been known for many years. At one time it seemed likely that copper mining in the territory would become an important industry. Several companies were formed with a view to exploiting the copper deposits, but for various reasons, including the superior attractions of the neighbouring Katanga field, and the lack of reasonable transport facilities and of sufficient working capital, copper production lagged and, indeed, was practically suspended for some years. The principal known deposits of copper ore have been acquired by British companies and are described below.

In 1910, a company was formed to acquire and develop copper deposits at Bwana M'Kubwa near the northern border, about 1,500 miles by railway from Beira. These deposits were included in 450 mining claims, beside which the company acquired the immediately surrounding area of 36,000 acres, 90 mining claims on a limestone area and 150 claims on iron-ore deposits. The total area acquired comprised about 70 sq. miles, of which about 56 carry mineral rights. The deposits are found on a prominent kopje about half a mile long and 100 ft. high, and the ore minerals are present as impregnations in a felspathic quartzite. The mine has been extensively developed, and it is estimated that the ore reserves amount to 3 million tons carrying 4 per cent. of copper, and that each additional 150 ft. in depth would add a million tons to these reserves. This somewhat low-grade ore is said to be amenable to flotation concentration. A special flotation plant with a daily capacity of 100 tons of ore has been erected, and is reported to give satisfaction. The last recorded production was for 1917–18, when 16,295 tons of ore yielded 1,419 tons of concentrate carrying 40 per cent. of copper.

Another company controls a number of small individual mines scattered over three adjoining blocks of mining claims of 10 sq. miles, each about 15 miles south of the Kafue River. Other interests acquired by this company were 160 mining claims known as the Hippo mine, and two farms of 3,000 acres each, making a total area of 25,200 acres. Some development has taken place

and a 25-ton copper smelter has been erected; but the total production so far has not exceeded 7,000 tons of smelted copper, and the latest report states that operations are confined to the working of two of the mines by tributors. Development of the properties is handicapped by their being at distances ranging from 50 to 100 miles of the railway, and apparently the individual properties are not linked up by any satisfactory transport scheme.

Some 80 miles to the north-west of Bwana M'Kubwa, and very near the northern border, is the Kansanshi Copper and Gold mine. The property consists of 90 mining claims, on which is a mine in a fairly advanced stage of development and a copper smelting plant. Mining operations were suspended in 1914, and since then conditions have not been favourable for their resumption. In the last eight months of working it is stated that 271 tons of copper were produced, valued at £15,234.

According to a report by E. M. Weston, between Bwana M'Kubwa and Kansanshi mine some large bodies of copper ore exist, which have not yet been fully explored. Some occur as fissure lodes and others as impregnations of copper minerals in felspathic quartzites and sandstones as at Bwana M'Kubwa, from which they are separated by a granite intrusion.

The M'Kana deposits about 30 miles west of Bwana M'Kubwa are in mica-schists, and have been explored below water-level. They are said to consist of malachite together with silicate and black oxide of copper, in association with manganese and iron oxides in the oxidised zone. Below this zone the chief copper mineral appears to be bornite. This deposit has been traced for a length of 5,300 ft., and the mineralised zone appears to have a width of 20 to 100 ft.

According to Weston, another ore-body in the form of a lode proved over a length of 1,800 ft. with a width of 50 to 80 ft. exists in this district. The copper content of the oxidised ore is 7 to 11 per cent., but the effect of leaching is apparent and secondary enrichment may be anticipated at a greater depth.

Near Susaka is a fissure lode in gneiss proved for a

length of 1,200 ft. and with a width of 4 ft. This lode is reported to contain ore averaging 9 per cent., or more, of copper.

The presence of these ore-bodies and the similar geological associations generally seem to point to the Northern Rhodesian deposits of copper ore as belonging to the same mineralisation period as the Katanga copper belt, and therefore it would not be surprising to find this part of the territory developing into a copper-field of the first importance.

Lead and Zinc.—The only important deposits of lead and zinc ores yet discovered in Northern Rhodesia are those at Broken Hill, 374 miles north of Victoria Falls, and near the railway from Livingstone to Katanga. The country rock of this district is dolomite of Silurian age, and the ore-bodies consist of irregularly shaped pipes in this rock as a mixture of lead and zinc minerals cementing dolomite breccia. The greater resistance to weathering agencies of the mineralised zones compared with that of containing rocks has resulted in their forming a series of kopjes or small hills 60 to 90 ft. above the plain. These hills consist almost entirely of oxidised ore, the principal lead mineral being the carbonate and the principal zinc mineral the silicate (calamine); but other less common lead and zinc minerals are present, as well as vanadinite, a vanadate of lead, and descloizite, a vanadate of lead and zinc. The deposits have been acquired and are being worked by the Rhodesian Broken Hill Development Co., Ltd., who have adopted an active development policy, and at the date of the last published report it was estimated that the ore reserves amounted to 650,000 tons of oxidised zinc-lead ore, and 104,000 tons of sulphide zinc-lead ore. In 1916, the company erected a blast furnace and commenced to smelt lead ore on a small scale. Since that date the smelter capacity has been increased to about 1,500 tons of lead per month, and the actual production for the years 1919 and 1920 was 14,174 and 16,354 tons respectively, while for 1921, according to the Annual Report of the Rhodesian Chamber of Mines, it was 18,122 tons. The zinc ores, which appear to be by far the most abundant, have not yet been treated for the recovery of

zinc, but it is stated that experimental metallurgical work is in progress.

The history of this undertaking is one of difficulties encountered and to a large extent overcome. The somewhat exceptional character of the oxidised ore baffled the earlier attempts at treatment, whilst at a small depth below the surface level of the plain, large quantities of water were encountered, which threatened to make the cost of pumping exceed the commercial value of the ore. However, both of these difficulties appear to have been more or less successfully surmounted, as indicated by the profitable production of lead, and by the fact that the use of the "cementation" process has made it possible to sink shafts to a considerable depth into the water-bearing rock. These shafts are equipped with pumps of a capacity of 6 million gallons per 24 hours; and, according to the latest reports, the water-level is being steadily lowered. The prospects of this undertaking appear to be good, but much depends on a satisfactory solution of the problem of treating the oxidised zinc ore. It is believed that below the oxidised zone the ore-bodies are of the normal galena-blende type, which can be treated by well-established methods.

Vanadium.—The vanadium minerals at Broken Hill appear likely to become important. According to official figures, production commenced in 1921, when the output was 6·18 tons of ore, valued at £2,401. The Company reports that the vanadium ores of various grades on the mine dump and at the smelters in June 1922 amounted to 7,617 tons, averaging 5·9 per cent. of vanadic oxide.

Bismuth.—Bismuth in small quantities has been mined in the Susaka district, but so far not in important quantities. A more promising area appears to be the Kaombo field in the Luano Valley, about 100 miles east of Broken Hill and 90 miles from the railway. Fissure veins carrying good grade ore in the form of bismuth sulphide, associated with pyrite in quartz, traverse chloritic schists. These veins are reported to be small, but include one proved for a length of 500 ft.

Mica.—It is reported that in the Susaka district mica of a commercial grade is found, and a small output for

the year 1920 has been recorded. Further information, however, does not appear to be available.

Tin.—According to Studt, the Nzilo rocks in the north-eastern part of the territory include some that are tin-bearing. The tin is found in veins in quartz-mica-schists and tourmalinites near granite intrusions, and connected with these veins there is some alluvial tin. Nothing can be said at present as to the commercial aspect of these deposits.

Coal.—Coal is found in four seams aggregating about 19 ft. in thickness in the Luano Valley, on the north-eastern boundary of the territory. According to an estimate by H. B. Maufe of the Rhodesian Geological Survey, the probable reserves are about 22 million tons with large possible reserves. This coal is bituminous in character and includes some with a low proportion of fixed carbon.

A second coal-field is found at Lufira and Losito on the Zambesi River, where two seams of bituminous coal, 4 ft. and 3 ft. thick respectively, are reported. Maufe estimates the probable reserves at 38 million tons, and considers that the possible reserves may be large. There seems to be no doubt that there is coal in the territory suitable for domestic and industrial uses, including the production of metallurgical coke, but the development of the coal-fields is not likely to outstrip the development of the other natural resources.

Future Mineral Development.—Over wide areas of the territory where the presence of ore deposits is probable, a heavy overburden of detrital material exists, making prospecting difficult and costly. At other points, where mineralised rock is exposed, oxidation of the metallic minerals, accompanied by surface leaching, has impoverished the outcrops, so that no reliable estimates can be made by merely superficial examination. On the other hand, it has been stated that, notwithstanding the disadvantages attending prospecting, Northern Rhodesia is one of the most promising mineral areas in the world for the skilled prospector. Native labour is very cheap, and the country is not unhealthy for Europeans.

The great need of the territory, not only for the development of its minerals, but for all other natural resources, is

the provision of large additional railway communication, but the immediate prospects for this are not favourable. The railway distance to Beira can be shortened by about 600 miles by building a comparatively short railway connecting Eldorado in Southern Rhodesia with the Livingstone–Katanga section in the vicinity of Broken Hill. Of great service to the territory, particularly the present isolated north-west portion, would be the extension of the Benguella (Lobito Bay) railway to the Katanga copper-field. This will probably be made in the near future, as its great importance is obvious. In the meantime transport by light river craft is the only available method for a great part of the territory, and there are large districts in which even this cannot be employed.

REFERENCES TO PRINCIPAL LITERATURE

Studt, F. E.: "Some Notes on the Geology of Katanga and Copper Belt." *Trans. Geol. Soc. South Africa*, Vol. 12, 1909, p. 159.

Studt, F. E.: "The Geology of Katanga and Northern Rhodesia." *Trans. Geol. Soc. South Africa*, Vol. 16, 1913, p. 44.

A Handbook of Northern Rhodesia, Livingstone, 1922.

Ann. Repts. Rhodesian Chamber of Mines.

Skinner's Mining Manual, London, 1922.

Guide to Rhodesia (issued by Beira and Rhodesia Railways), Bulawayo, 1914.

Gouldsbury, C., and Sheave, H.: *The Great Plateau of Northern Rhodesia.* E. Arnold, London, 1911.

Reed, F. R. C.: *Geology of the British Empire.* E. Arnold, London, 1921.

Mining Magazine, Aug. 1921, pp. 68 and 127.

Speak, S. J.: "Lead-Zinc Deposits at Rhodesian Broken Hill." *Mining Magazine*, Oct. 1919, p. 203.

Times Trade Supplement, May 6, 1921.

Maufe, H. B.: *Coal Resources of the World*, Vol. 2, 1913, p. 393 (Rhodesian Section).

Weston, E. M.: "South African Mining." *Chem. Eng. and Min. Rev.*, June 5, 1921, p. 310.

THE MINERAL "BENTONITE": ITS OCCURRENCE AND USES

WITHIN the last few years the remarkable properties of the comparatively little-known mineral "bentonite" have attracted considerable attention, and much fruitful research has been completed which has shed light on the

constitution of this substance and has led to the development of methods for its useful application to many arts and industries.

Description

Bentonite, which is sometimes known as Denver mud or clay, medicinal clay, paper-clay, soap-clay, or gumbo, is a peculiar variety of bedded clay which has so great an affinity for water that some varieties will absorb more than three times their own weights and up to eight times their own volumes of water, swelling up considerably and producing a jelly-like mass exhibiting colloidal properties and closely resembling some of the thicker preparations of starch paste commonly used for adhesive purposes.

The material was first described by W. C. Knight from the Laramie Basin, Wyoming, U.S.A., under the name "taylorite"; but, because another substance had already been given that name, he renamed it "bentonite," in view of the fact that the clay was associated with beds of the lower Benton formation (of Upper Cretaceous age).

In appearance bentonite is similar to many other kinds of clay, especially those commonly designated "soapy" clays; it is usually hard, dull, and powdery, but sectile, and waxy on a freshly cut surface. The colour varies considerably, and may be any shade from yellowish-green to almost black, pink and white varieties also having been noted. It is exceedingly fine-grained and becomes very plastic when wet. Microscopic examination of the wet clay sometimes shows the particles to be rounded and of very minute but uniform size; they are, however, usually too small to be seen at all, even with a high-power objective. With an excess of water the greater part of the clay remains indefinitely in suspension.

Bentonite, like other clays, consists essentially of aluminium silicate, but varies somewhat in composition, its peculiar properties being due to its physical condition. It has been stated that the mineral is characterised chemically by an alkaline oxide and alkaline earth content of 5 to 10 per cent., but analyses show very wide varia-

tions from these figures, as may be seen from a consideration of the following selection :

Analyses of Bentonite

		I.	II.	III.	IV.	V.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Silica	SiO_2 .	60·18	63·20	59·84	69·52	69·46
Alumina	Al_2O_3 .	26·58	12·90	11·84	21·64	16·25
Ferric oxide	Fe_2O_3 .	—	2·46	3·26	3·06	3·35
Lime	CaO .	0·23	0·82	2·90	nil	2·06
Magnesia	MgO .	1·01	2·09	2·32	0·21	2·76
Alkalis	. .	1·23	·92	4·47	nil	1·08
Loss on ignition	.	10·26	13·80	10·50	5·45	5·04

I. Type material, near Rock Creek, Laramie Basin, Wyoming, U.S.A.
II. From Big Horn Basin, Wyoming, U.S.A.
III. From Otay, San Diego County, California, U.S.A.
IV. Colloidal material washed from bentonite, taken from between coal seams Nos. 6 and 7, near Gibson mine, Drumheller, Alberta, Canada.
V. From the main parting in No. 1 coal seam, Rosedale mine, Alberta, Canada.

Occurrences

The chief deposits of bentonite hitherto described are located in the continent of North America. In the United States the beds are numerous in Wyoming, especially in the Laramie and Big Horn basins, the latter extending into Montana. Other deposits occur in South Dakota, California, Utah, Arizona, Texas, Tennessee, and New Mexico. Canadian bentonite is abundant in the Edmonton and Belly River formations (Upper Cretaceous) of Alberta, especially in the Red Deer and Rosebud river-valleys near Drumheller. Several occurrences have been noted in British Columbia. It is probable that some of the deposits hitherto recorded as "clay" in other parts of the globe will eventually turn out to be of the bentonite variety.

The Wyoming bentonite occurs in almost horizontal beds which vary in thickness from a few inches to more than 5 ft., and are both overlain and underlain by dark shale. The worked deposits lie near the surface, and rough joints perpendicular to the bedding facilitate mining. The bentonite is hand-shovelled into wagons and taken to Chicago for grinding and further preparation. The Californian deposits are mined by underground methods and refined at Los Angeles.

A special variety known as "ardmorite" is found

in the Pierre shales at Ardmore, South Dakota. It is grey in colour and, unlike typical bentonite, does not remain indefinitely suspended in water. Mining methods include drilling and blasting, the crude material so obtained being milled at the railhead by an elaborate process. After weathering in stockpiles in the open, the clay is dried [illegible] layers [illegible] steam coils. It is then crushed in a hammer-mill, and after screening is taken to the disintegrators and thence to a pug-mill where it is kneaded with water. Then it is pressed through dies of $\frac{1}{16}$ to $\frac{1}{8}$ in. in diameter into strings which are afterwards dried in a steam-heated tunnel. The dry strings are crushed by a hammer-mill and then screened, the fines being re-treated and the remainder baked in an oil-fired rotary kiln. This baked product is then re-hydrated, washed with water in wooden towers, again screened, drained, and packed in barrels or stored in vats. The product finds a special use as a softener for water containing much calcium sulphate.

The Alberta bentonite also occurs in persistent, regular, and almost horizontal beds varying in thickness from a fraction of an inch up to 6 ft. It is associated with the coal seams (especially the lowest and thickest, or No. 1 seam, which it divides), and often impregnates the sandstones and shales of the formation. The bentonitic sandstones, which are hard when dry, contain up to 45 per cent. by weight of bentonite, which can be seen microscopically coating the individual sand grains. This results in the softening and swelling of the sandstone and its consequent easy erosion when exposed to moisture, which has a profound influence on operations in the coal mines. Owing to this fact also, many of the roads in the Red Deer and Rosebud valleys, especially those on which steep slopes occur, become impassable to wheeled traffic in wet weather, the surface becoming quite soapy. Many of the Quaternary glacial clay deposits in these valleys are derived from the Cretaceous bentonites and possess similar properties. It is these surface clays which have received the name "gumbo." The Alberta deposits are not yet developed to a great extent owing to the comparatively impure condition of the bentonite hitherto discovered.

Uses

The uses of bentonite are manifold. It was known to and used by the native Indians and Hudson's Bay Company employees long ago as a substitute for soap, but it is only within the last three years that considerable demand has arisen for the product, with consequent increases in price and production. Bentonite was formerly chiefly used in the manufacture of "antiphlogistine," a medical absorbent dressing; as a packing and dressing for horses' hoofs; as a retarder in making gypsum wall plaster; and as a filler for paper and soap. Research has shown that in the manufacture of soap, bentonite may be used to replace 25 to 30 per cent. of the soap substance producing an equally efficient soap, and it is claimed that the detergent and lathering properties are actually increased by this means.

Experiments at the Forest Products Laboratory of the Wisconsin Department of Agriculture, using bentonite as a paper filler, have demonstrated that the percentage of filler retained is increased 100 per cent. as compared with the usual clay filler. The resultant paper has a superior feel, but is yellowish in colour. Other experiments at the same laboratory on de-inking printed paper show that bentonite tends to absorb the ink, but has no effect on the pulp.

It is not known whether all bentonite possesses the property of softening water like that from Ardmore, South Dakota, mentioned above, but it seems likely that those rich in alkaline oxides may be of use for this purpose.

On account of its extreme hardness when burnt it finds a use as clay ballast in constructing certain types of roads.

Although previously regarded as of no use for ceramic products, experiments by Keele (*Geol. Survey of Canada, Memoir* 25, p. 83, and *Memoir* 66, p. 45) on some bentonite clays from Alberta have demonstrated that these can be rendered workable by a pre-heating process carried out in a rotary kiln at from 400° to 600° C. Pre-heated clays produce an open granular body which does not require so much water for mixing, with consequent lower air shrinkage. The drawback to this method is its cost, but many other experimental methods have been tried and have all failed.

Bentonite has recently been utilised in the sizing of yarn for the textile industry. It is said to make a good adhesive paste, especially for use with paper on metal.

It has been suggested that the affinity of bentonite for water might be applied to the de-watering of crude petroleum, and among the many other suggested uses to which bentonite could be put are: the cleansing of cloth; the clarification of oils; as a filler for rubber, gramophone records, textiles, cordage, and pressed and moulded electrical insulation; in the manufacture of paint; replacing bonding clay in the manufacture of electrical and chemical porcelain, abrasive wheels and graphite crucibles; as a base for precipitating lake colours; as a base for massage cream and printers' ink; mixed with oil as a heavy lubricant; as a dressing for leather; and as an absorbent in dynamite manufacture.

It is therefore apparent that this substance seems likely to become of considerable commercial importance, and deposits of clay throughout the Empire should be examined in order to find out if they are of this variety. It is quite simple for any amateur prospector to test a suspected sample by dropping it into a cup of water, when, if it is bentonite, it will swell and rapidly assume the consistency of soft soap, afterwards going completely into suspension. A confirmatory test could be applied by holding a thin splinter in a blowpipe flame, when bentonite would readily fuse at the edges, whilst ordinary clay would not. Any promising samples which might be discovered should be forwarded to the Imperial Institute for investigation.

Specimens of bentonite can be inspected at the Imperial Institute.

LIST OF REFERENCES TO THE PRINCIPAL LITERATURE

Engineering and Mining Journal, vol. 62, 1898, p. 600.

"The Clay and Shale Deposits of the Western Provinces." Memoirs Nos. 24-E; 25; 47; 65 and 66, Geological Survey of Canada, 1912-15, by H. Ries and J. Keele.

"Useful Minerals of the United States." Bulletin 624, United States Geological Survey, 1917.

Third Annual Report of the Scientific and Industrial Research Council of Alberta on the Mineral Resources of Alberta, 1921, by John A. Allan.

Reports of Investigations No. 2289, U.S. Bureau of Mines, 1921, by R. B. Ladoo.

NOTES

The Agricultural and Forest Products of British West Africa.—A new edition of the book by Mr. G. C. Dudgeon, C.B.E., published under this title in the series of *Imperial Institute Handbooks to the Commercial Resources of the Tropics*, has just been issued by Mr. John Murray (price 7s. 6d.). The volume is divided into five parts dealing respectively with the Gambia; Sierra Leone; the Gold Coast, Ashanti, and the Northern Territories; Nigeria—Southern Provinces; and Nigeria—Northern Provinces. The subject-matter, which has been thoroughly revised and brought up to date, is illustrated by five maps and numerous photographs representative of the products and industries of the countries dealt with. A general account is given of each country, including its geographical position, area, tribes, political divisions, climate, soil, form of land tenure, methods of cultivation, etc. This is followed in each case by full particulars of the agricultural crops and the natural products of the forests, special attention being devoted to the staple crops, such as cocoa, oil palm, ground nuts, cotton and rubber.

Rubber Vulcanisation.—In this BULLETIN (1916, 14, 499) an account is given of the methods of rubber testing adopted at the Imperial Institute. The extent of vulcanisation is measured by the percentage elongation of the rubber at a given load. The more the rubber stretches the less it is cured and *vice versa*. Vulcanisation, however, not only involves a change in the physical properties of rubber, but also, as the operation proceeds, more and more sulphur is rendered insoluble in the usual solvents, such as acetone, and presumably combines with the caoutchouc in the rubber. It is possible therefore to measure the extent of vulcanisation by determining the amount of sulphur which can no longer be extracted by acetone. This is generally known as the "coefficient of vulcanisation."

A paper on "The Coefficient of Vulcanisation of Rubber," by G. Martin, B.Sc., A.I.C., and F. L. Elliott, A.I.C., of the Scientific and Technical Staff of the Imperial Institute, has recently been contributed to the *Journal of the Society of Chemical Industry* (July 15, 1922). The work was carried out in connection with the Ceylon Rubber Research Scheme and was subsidiary to investigations previously undertaken on samples supplied from Ceylon.

Series of sheet and crêpe rubbers from two groups of

trees were vulcanised and the extent of vulcanisation measured both by the physical and chemical methods. It was found that, although there was a close correspondence in the results yielded by the two methods, differences occurred which were larger than could be accounted for as experimental error. The authors were able to connect these differences with the percentages of "resin" in the rubber so long as rubbers from the same group of trees and of the same form were compared. In addition, by adding 2 per cent. of crêpe rubber "resin," 2 per cent. of sheet rubber "resin," and 2 per cent. of slab rubber "resin" in turn to a sample of untreated crêpe rubber, and vulcanising each of the three products so obtained, it was found possible to increase still further the difference in the results yielded by the chemical and physical methods of determining the extent of vulcanisation. The authors were able to show, moreover, that while crêpe rubber "resin" had little effect on the time of vulcanisation, sheet rubber "resin" caused a slight reduction, and slab rubber "resin" a large reduction in the time.

New Rubber Research Laboratories.—The Research Association of British Rubber and Tyre Manufacturers was founded in 1919 under the auspices of the Department of Scientific and Industrial Research with the object of studying the fundamental problems of the rubber manufacturing industry and of collecting information and conducting investigations in connection with the control of manufacturing operations and the methods of testing raw materials and final products.

For the last two years the Research Association has been carrying on its work at University College, London. It has now obtained laboratories of its own at Croydon, and these were formally opened by the Right Hon. Lord Colwyn on July 26th, 1922.

Recent Developments in the Use of Titanium Dioxide as a Pigment.—The problem of the utilisation of many of the so-called rare elements is one which offers a wide field for investigation, and of recent years much work has been done in this direction. Progress, though necessarily slow, is constantly being made, and new applications of hitherto comparatively useless substances are being discovered.

Since the publication of an article in this BULLETIN (1917, **15**, 82) on "The Distribution and Uses of Titanium Ores," considerable development has taken place in the

utilisation of titanium compounds, and the oxide of the metal promises to find application as a pigment. This development is due not only to the desire to find additional uses for titanium, but has been stimulated by the need of a satisfactory substitute for white lead.

As only a brief reference to the subject, which was then in the experimental stage, was made in the above-mentioned article, it may be of interest to describe the procedure now adopted in the preparation of titanium pigments in Norway and the United States. In the former country, the plant, which commenced operations in 1919, is capable of producing 8,000 tons of pigment per annum.

Two classes of titanium pigment are made: (1) a white titanium pigment, consisting chiefly of titanium dioxide, and (2) a composite pigment, consisting of titanium dioxide on a base of barium sulphate. The ore used in Norway is stated to be a form of ilmenite, from the "Blaafjeld" and "Storgangen" deposits of Raagefjord and Jössingfjord, and contains from 25 to 45 per cent. of titanium dioxide. The process described below, which is largely taken from a paper by Noel Heaton, B.Sc. (*Journ. Roy. Soc. Arts*, 1922, **70**, 552), is that used in the manufacture of the composite pigment, that employed for the production of the pure titanium pigment apparently being similar in most respects, except as regards the addition of barium sulphate.

After preliminary sorting, classification, and washing, to remove impurities and associated minerals, the ore is dried, finely ground, and decomposed with hot sulphuric acid. The product, consisting largely of hard cakes of iron and titanium sulphates, with sulphuric acid, is ground up and dissolved in water, any undecomposed mineral being separated by settling. The clear liquid is electrolytically reduced, the desired proportion of barium sulphate is added, and on heating the mixture to boiling, and keeping it in a state of agitation for a considerable time, titanium dioxide is deposited on the barium sulphate as a white amorphous precipitate. The extreme fineness of the precipitate renders filtration impracticable, and it is necessary to wash it by decantation. Small quantities of sulphuric acid remaining in the precipitate are neutralised by the addition of barium carbonate. It has been found that if this precipitate is now calcined it will acquire a yellowish tinge, but this discoloration is avoided by adding a small quantity of a phosphatic substance before calcination. The mixture is then calcined at a suitable temperature, and by means of pulverisation and air flotation is

reduced to such fineness that only 0·1 per cent. is left on a sieve of 300 meshes to the linear inch.

The ground pigment is ready for use after incorporation with linseed oil. Owing to the fact that titanium dioxide and barium sulphate do not exert any chemical action on the oil, it is desirable to add a small proportion of zinc oxide, which affords the necessary hardening qualities to the paint film, which would otherwise be somewhat elastic.

The description of this material as "titanium" pigment may perhaps be regarded as somewhat a misnomer, as the standard commercial product contains only about 25 per cent. of titanium dioxide, the remainder being barium sulphate, which provides a means by which the high opacity possessed by titanium dioxide can be most economically exhibited.

Titanium dioxide possesses properties which render it peculiarly suitable for use as a pigment. It is very stable, and resists the attack of sulphuric acid and other corrosive substances, and is not discoloured by sulphuretted hydrogen. The opacity is much higher than that of other white pigments, and the specific gravity is low.

The following table (Washburn & McGougan, *Proc. of Paint and Varnish Soc.*, March 1921, "Titanium White, its Production, Properties and Uses") summarises the properties of titanium pigments in comparison with those of white lead and zinc oxide.

Pigment.	Paint from 100 lb. of pigment.	Paint from 100 lb. of pigment.	Weight per gal.	Area covered by 1 gal. of paint.	Area covered by 100 lb. of pigment.	Absolute hiding power of 1 gal. paint.	No. of coats of paint theoretically required to hide completely a black surface.	Area completely hidden by 100 lb. of pigment.
	lb.	*gals.*	*lb.*	*sq. ft.*	*sq. ft.*	*sq. ft.*		*sq. ft.*
Zinc oxide .	182·6	10·57	17·3	880	9,300	174	$\frac{880}{174} = 5·03$	1,840
Basic carbonate white lead .	144·35	6·24	23·1	720	4,500	292	$\frac{720}{292} = 2·47$	1,820
Titanium white .	172·2	10·2	16·9	1,000	10,200	492	$\frac{1000}{492} = 2·04$	5,010
Composite titanium pigment .	161·7	8·8	18·4	1,015	8,920	447	$\frac{1015}{447} = 2·27$	3,940

RECENT PROGRESS IN AGRICULTURE AND THE DEVELOPMENT OF NATURAL RESOURCES

In this section of the Bulletin a summary is given of the contents of the more important papers and reports received during the preceding quarter, in so far as these relate to tropical agriculture and the utilisation of the natural resources of the Colonies, India and the Tropics generally. It must be understood that the Imperial Institute accepts no responsibility for the opinions expressed in the papers and reports summarised.

AGRICULTURE

Foodstuffs and Fodders

Coffee.—A report of a year's tour of inspection of coffee estates in Uganda by C. H. Lankester of the Las Concaras Estate, Costa Rica, is published as *Circ. No. 7, Dept. Agric., Uganda Protectorate.* Of the 25,437 acres under cultivation in 1920, 445 were planted with *Coffea robusta*, while the remainder was devoted to *C. arabica*. The latter consists of two varieties, known respectively as Nyasa and Bourbon, the former being indistinguishable from that grown in Costa Rica. Nyasa prospers best in warmer and moister regions, and Bourbon in the higher and cooler districts. Nyasa gives a higher percentage of large and well-formed beans than Bourbon, while the latter is more resistant to die-back but more subject to severe infestation from leaf disease (*Hemileia vastatrix*). Where shade is not considered advisable Bourbon offers the greatest number of advantages, and in addition it gives an early crop. Robusta, which is apparently indigenous to Uganda in regions bordering on the Congo, thrives in almost any situation where coffee is grown, but is especially suited to the lower elevations. It has great natural strength and quick growth, and the writer considers that the variety is much more likely to give satisfactory results if the system of pruning followed in either Costa Rica or Guatemala is adopted. It is more resistant to disease than *C. arabica* types, and is eminently fitted for native cultivation. It is pointed out, however, that London brokers show a preference for coffee of the Bourbon type owing to its good liquoring qualities. A few trees of native-grown coffee occur in all districts, though only in one case was any promise of eventual success observed, and on the whole the amount of native production is negligible. The report gives in detail the systems of pruning in use in Uganda and Costa Rica, with diagrams of the practice in the latter country, and the question of shade and wind-breaks is fully dealt with. For the latter purposes the writer

suggests the introduction and trial of *Inga* spp., now used almost exclusively in Central America, *Ceratonia siliqua* and *Hymenæa courbaril*, while of the local trees he considers that a species of *Albizzia* (*A. brownii* ?) would prove the most useful. For permanent wind-breaks in coffee plantations, *Cassia floribunda*, *Erythrina* spp., and *Grevillea robusta* are the best available. The last-named, however, is considered as very undesirable for shade purposes. Diseases, pests and weeds are discussed at length and a short account is given of Costa Rican practice in cultivation, harvesting, etc. A comparison of yields and cost of production in Uganda with those of Costa Rica, together with notes and suggestions, concludes the report.

The Food Plants of the Philippines.—*Philippine Agric. Rev.* (1921, **14**, No. 3) is devoted to a special article in which 444 species and sub-species of food plants growing in the Philippines are described. The Philippines have 121 native species of alimentary plants, while since 1900, 110 species have been introduced. The list is arranged alphabetically under the common name of the plant, an index by species being provided at the end of the article.

It is pointed out that the culture of a number of the best fruit trees is confined to certain small districts, while in other districts equally well adapted to them they are entirely unknown. It is suggested that the extension of the cultivation of the most valuable fruits should be fostered, and it is stated that the agricultural industries as a whole call for better organisation, in order that much of the foodstuffs now imported may be produced in the islands. In this connection it is mentioned that large quantities of rice and wheat flour are imported annually together with cocoa, coffee, dried legumes, potatoes, onions, canned fruits and vegetables.

Rhodesian Grasses.—The *Rhodesian Agric. Journ.* (1922, **19**, 134) contains an account of investigations which have now been in progress for eleven years concerning the improvement of Rhodesian pastures, and deals with the composition, feeding value, description and field characteristics of grasses of agricultural importance in Southern Rhodesia. Although much work remains to be accomplished, the results of the completed trials indicate that little can be hoped for from exotic species, and that for the improvement of the unirrigated and possibly the irrigated pastures also, the most promising grasses are to be found amongst the native and South African varieties.

At Salisbury Experiment Station there are under observation and trial at the present time 55 native Rhodesian species or sub-species, 10 African (other than Rhodesian) species and 10 species exotic to Africa.

The following records refer mainly to these grasses when grown on red soil in Mashonaland. Their behaviour on black soils will probably be even more satisfactory, but on sandy soils their relative merits have yet to be demonstrated. Of the native Rhodesian Grasses, Rhodesian Tussock Grass (*Setaria Lindenbergiana*, Stapf) grows to a height of 3½ feet and a five-year-old stool may have as many as 700 leafy stems. Fully grown plants on a small plot cut in March 1921 yielded 34,270 lb. of green fodder per acre. False Paspalum (*Brachiaria brizantha*, Stapf) occurs in two varieties, the broad-leaved and the fine-leaved. Both types are useful, the fine-leaved being the more valuable, but neither appears to rank amongst the best of the indigenous grasses for permanent pastures. Swamp Couch Grass (*Hæmarthria fasciculata*, Kunth) occurs naturally only on wet, ill-drained soils. It is a wiry grass, the stems usually being more in evidence than the leaves. It affords probably the best grazing grass for black soil or water-logged pastures, and trials now being carried out with this grass on drier red soils are promising. Fine-leaved Guinea Grass (*Panicum maximum*, Jacq.) is more upright in growth and finer in leaf than ordinary Guinea Grass, and less upright and coarser than the Buffel grasses, these grasses being also regarded at present as *P. maximum*. Fine Guinea Grass has yielded 15 tons per acre of green fodder from a single cutting, and is suitable for green soiling or grazing, being superior for this purpose to Napier fodder, owing to its finer and more succulent character. Buffalo Grass (*Setaria sulcata*, Raddi), though a bunch variety, may be regarded as an extremely valuable pasture grass, and well deserving of being planted in large areas. It is characterised by large, broad, coarsely corrugated leaves which may be as much as 3 feet long by 3½ inches wide, and in either its green or dry state is readily eaten by cattle and has a high feeding value. Golden Timothy Grass (*Setaria aurea*, A. Br.) is well known for its nutritive qualities, and is much liked by all classes of stock, but it does not provide a very heavy yield of hay or of pasturage; after being cut, however, it makes a good aftermath which continues fairly green into late autumn. During mid-winter the grass is practically dormant, but provides a good early spring fodder. Red Rhodes Grass (*Eustachys petrea*, Nees) seldom attains to more than 18 inches in height, and it is doubtful whether it possesses any advantage over

ordinary Rhodes grass (*Eustachys Gayana*). Antelope Grass (*Echinochloa pyramidalis*, Hitchc. and Chase) and Tall Couch Grass (*Cynodon Dactylon*, Pers.) have shown no outstanding merit, and while deserving of encouragement under natural conditions, they are not worthy of being grown for pasture in preference to other more valuable grasses. Native Paspalum (*Paspalum scrobiculatum*, Linn.) frequently occurs with swamp couch grass. It is more sensitive to frost than either *Paspalum dilatatum* or upright paspalum, but is remarkable for its early spring growth, and promises to prove of considerable value. A full season's growth of this grass when cut has yielded 19,950 lb. of green fodder per acre.

Of the introduced grasses, exotic to Rhodesia, the behaviour of Kikuyu (*Pennisetum clandestinum*, Stapf) is of great interest (cf. this BULLETIN, 1921, **19**, 214). It was obtained from Kenya Colony, and good results have been secured by planting it on the edges of wet sand vlies, but it does not appear to thrive on heavier, wet, black soils or on dry sands. On the Experiment Station it has not responded to moderate top dressings of either farmyard manure or artificial fertilisers, but heavy dressings of the former have been of benefit. Where it thrives, kikuyu forms an admirable pasture especially for sheep, but is sometimes too short to afford much food for cattle. It appears rapidly to exhaust the land for itself, though not for following crops, and quickly to become sod-bound. Present evidence indicates that dry land pastures of this grass cannot with advantage be grown in Rhodesia for more than three to five years. Of the other exotic grasses, Natal Grass (*Pennisetum unisetum*, Benth.), Perennial Canary Grass (*Phalaris bulbosa*) and African Star Grass (*Cynodon plectostachyum*, Pilg.) are likely to prove of value, while Upright Paspalum (*Paspalum virgatum*) possesses no advantage over native paspalum, and Rhodes Grass (*Eustachys Gayana*) is only of value under irrigation.

OILS AND OIL SEEDS

Coconuts.—A bleeding disease of coconuts, which affects palms in many widely distant localities of India, is the subject of *Bulletin No.* 127, 1922, *Agric. Res. Inst., Pusa.* The first indication that the disease is present in a tree is the oozing out of a dark reddish-brown fluid from cracks on the surface of the stem. Below the wound the tissue is decayed and yellow. In its early stages the decay of the tissue is localised, but in advanced stages, when more

than one bleeding patch can be seen, a general decay of the internal tissue takes place. When this stage is reached the tree ceases to bear fruit, the crown dwindles and the tree dies. The cause of the disease has been ascribed to a fungus, *Thielaviopsis paradoxa*. From the results of experiments it is deduced that the fungus enters the tree through wounds or cracks, caused by injury to the stem. When coconut trees are found to be infected, the removal of the diseased parts is the easiest and most effective remedy. This can be done by means of a chisel, the wound being afterwards scorched by the application of a lighted torch and treated with a coat of hot tar as an antiseptic. Care should be taken that all the diseased tissue is burned immediately after it has been cut out. These remedial measures were applied in 1918 to 100 trees which showed the symptoms of bleeding disease, and two years later they were all reported to be in a healthy condition.

An account of experiments carried out at Westerhall, Grenada, on red-ring disease, caused by a nematode, was given in this BULLETIN (1920, **18**, 291). Further experiments have been made to show the effect of an application of salt to the crowns of trees inoculated later with infested material (*Agric. News, West Indies*, 1922, **21**, 94). Crude salt, enclosed in a bag of gunny sacking, was suspended above the crown of each tree so that the rain draining through the bag could soak down to the bases of the expanding and expanded leaves. At the end of a fortnight the trees were inoculated by dropping into all the leaf-axils infested material taken from a diseased tree, and the salt was renewed from time to time. All the trees treated showed marked symptoms of disease in from two to two and a half months after inoculation. These experiments prove therefore that the treatment of the crowns with salt is quite ineffective in preventing or even in appreciably delaying infection. It must, however, be pointed out that the inoculation was extremely heavy. Under natural conditions the number of nematodes reaching vulnerable parts of the crown would be very small by comparison and a salt drip might be so effective as to reduce very materially the chances of infection. Further experiments were made in which the soil around the base of the trees was treated with salt and then inoculated by burying pieces of infected material in it. At the end of the experiment all the trees were found to be attacked by the disease, showing that salting the soil does not prevent infection. In a third series of experiments trees were banded with a mixture of tar and tallow,

9 inches wide at a height of 3 feet from the ground. The soil around the base of the trees was inoculated as in the previous series. These trees were also found to be infected and showed external symptoms of the disease after about five months from the date of the inoculation of the soil.

A small outbreak of bud-rot in Malaya in a field where nearly every coconut tree showed signs of the disease, some being in a very advanced state of decay, is described in a paper by Sharples & Lambourne (*Ann. Bot.*, 1922, **36**, 50; abstr. *Review of Applied Mycology*, 1922, **1**, 172). The primary cause of the attack was ascribed to the fact that the field was subjected daily to a tidal inundation. Cultures made from the diseased tissues showed the presence of three organisms, a red pigment-producing bacillus, a bacillus resembling *B. flavocoriaceus*, and a *Sarcinomyces*. Inoculations with cultures of these organisms were made in the heart tissues of the buds of mature palms which subsequently developed the early symptoms of bud-rot, characterised by the rotting and falling over of the central leaves. The trees recovered after a time and put out new leaves. Other inoculations were made with *Phytophthora faberi*, which causes the black stripe of *Hevea* trees in Malaya, a species of *Thielavia* and a *Mucor*, all of which gave results similar to those of the first set of experiments. The conclusions drawn from these experiments are that wound inoculations penetrating the central tissues of the bud will produce the symptoms of bud-rot, as judged by the rotting of the central leaves, with a variety of organisms, none of which can be regarded as specific to the disease. Although it has been proved that *Phytophthora palmivora*, Butl., in India and the West Indies functions as an obligate parasite on the tender central leaves of the palms, this organism is not considered by the authors necessarily to cause the rotting of the heart tissues and the death of the tree.

Oil Palms.—The development of the oil palm industry of the Gold Coast by the establishment of communal or co-operative power-driven factories is recommended by the Director of Agriculture in the *Journal of the Gold Coast Agricultural and Commercial Society* (1922, **1**, 70). Although in the past considerable attention was paid by the natives to the exploitation of the oil palm in the Gold Coast, this industry has been seriously neglected since the development of cocoa cultivation, which has been found to be more profitable. At the present time, it is estimated that palm products to the value of £1,000,000 are allowed to go to waste every year in the colony. It

is not suggested that the cultivation of cocoa should be abandoned or neglected, but rather that instead of extending the area planted with this crop, the surplus energy of the population should be devoted to the exploitation of the oil palm. The Director of Agriculture proposes that groups of farmers, who are owners of oil palm lands and are prepared to supply fruits to a factory, should form themselves into an association for this purpose. This association would purchase the machinery and provide the necessary buildings. The amount of capital required would depend of course on the capacity and equipment of the factory. It is estimated that for a factory to deal with 250 tons of fresh fruits per month, £10,000 would be needed. The members of the association would undertake to supply a definite quantity of fresh fruits to the factory yearly or monthly. These fruits would be paid for each month at a fixed rate and the profits shared out in the form of a bonus at the end of each financial year. In the event of the local people's inability to finance such a scheme, independent companies should be encouraged to erect factories and run them, the natives being responsible for a regular supply of fresh fruits. The proposed factories need not be large, but might be of such size as to deal with all the fruits within a radius of ten miles, thereby minimising the cost of transport to the factory.

RUBBER

Hevea brasiliensis

Uganda.—In *Circular No. 6, Dept. Agric., Uganda Protectorate*, an account is given of the conditions and prospects of Para rubber in Uganda. Altogether there are 17,500 acres of rubber trees under European management, and 900 acres planted by the natives. Since the mean height above sea-level of the Buganda Province, where most of the rubber is grown, is just under 4,000 feet, and the annual rainfall is only about 50 inches, the climate would not be regarded as altogether suitable for rubber growing. There are two factors, however, which do much to compensate for the deficient rainfall, viz. the regular distribution of rain throughout the year, and the high moisture-retaining capacity of the soil.

While the general appearance of the foliage exceeds all expectations, the rate of growth is found to be considerably less than in the East. Apart from the inferior size of the trees, the bark shows signs of backwardness, and the wood has not the sappy character noticeable in other countries. The seeds, on the average, are only

half the size of those from the Malayan trees, and a large proportion of them fail to germinate. Whereas in Malaya the usual age of bearing is five years, in Uganda it cannot be less than seven years. However, owing to the loss of top soil, the rain-drenched rubber-lands of the Federated Malay States are gradually losing their fertility with a resultant lag in the development of the rubber trees. In Uganda, on the other hand, the amount of wash is insufficient to bring about any material retardation in growth. Both in girth expansion and foliar spread, there is a steady improvement year by year, and it is estimated that eventually the yield on a Uganda estate ought to reach 300 lb. per acre, after making allowance for poor yields and disease. The yield is not so high as that obtained in Malaya, but there is compensation in the cheapness of labour. All the well-known stem diseases are in evidence in Uganda. Two of the most troublesome affections—stripe canker and brown bast—are very prevalent. In addition, a curious and abnormal scaling of the bark is common throughout the Protectorate. The trees are, however, fairly free from root disease. Intrinsically, the Uganda rubber is just as good as the rubber from Eastern plantations, and, provided that more care is exercised in its preparation, there is no reason why it should not command equal prices. Nearly all the Para rubber has been interplanted with Arabian coffee, as it was calculated by the local planters that after its third year the revenue from coffee would more than provide for the upkeep of the estates until the rubber reached the bearing stage. There is no indication of the rubber having suffered from the competition of the coffee bushes. Owing to the geographical situation of Uganda with reference to the world's markets, transport is very expensive. Up to May of this year the cost of railing and shipping 1 lb. of rubber to London was nearly 12 cents. The author of the *Circular* estimates that the total "all in" cost of rubber in Uganda shipped to London should vary from 2*s*. 2½*d*. in the eighth year to 9*d*. in the sixteenth year. He admits, however, that rubber from most of the existing estates will, through various planting defects, cost more than this. In conclusion, it is pointed out that an estate of 200 acres is the maximum size which labour conditions will allow, and that the financial prospects of rubber are good if it is grown as a subsidiary crop, with coffee as an intercrop.

Variability.—*Arch. voor de Rubber-cultuur* (April 1922, p. 160) contains an account of investigations on the quality of rubber from individual trees. The rubber was

prepared from latex from each of twelve trees which were 12 years old and all good yielders. The tests took place over a period of two years. The rubber content of the latex was found to vary from 25 to 40 per cent. It was often constant for long periods for one tree, but sometimes showed changes due to alterations in tapping systems or other causes. The rubber yield per day per tree varied from 9·6 to 68·4 grams. Some trees were found to give rise to rubber which on vulcanisation invariably had a low tensile strength, and others to rubber which always had a good tensile strength. The time required for vulcanisation was fairly constant when the rubber was prepared from latex from the same tree, but varied considerably for rubber prepared from the latex of different trees, viz. from 90 to 135 minutes. The viscosity of the rubber varied over a wide range and was not always constant when prepared from the latex of the same tree.

Die-back Disease.—The same journal, March 1922, page 93, describes experiments which suggest that the primary cause of die-back disease is not parasitic. A close relation was found between soil conditions and the incidence of die-back, indicating that the trees were suffering from faulty nutrition. It is supposed that with such physiologically weakened trees ordinarily harmless fungi may do some damage.

South American Leaf Disease.—Plantations in the East have hitherto been free from leaf disease, but owing to the extensive damage caused to South American plantations it was considered desirable that an investigation should be made by an officer of the Federated Malay States with a view to preventing its occurrence in Malaya. A report on his visit to South America is given in the *Agric. Bull., Fed. Malay States* (1921, **9**, 179). The conclusion is arrived at that it is highly improbable that the fungus responsible for the disease could ever be accidentally introduced into the East, or that, if introduced, it could do any appreciable damage.

Attention is called to the fact that little is known of the diseases of the rubber trees of Brazil, and it is argued that if fresh stock is imported it should be under strict scientific control in order to prevent the introduction of a disease comparatively harmless on the scattered trees of the jungle, but which might spread to an alarming extent on plantations.

FIBRES

Flax.—In this BULLETIN (1919, **17**, 605) reference was made to certain processes which have been devised for retting flax and other fibres in water inoculated with bacterial cultures.

The attention of the Imperial Institute has recently been directed to a new method of bacterial retting with a pure culture which has been discovered by M. Kayser and is claimed to possess certain advantages over other processes.

Retting takes place at a comparatively low temperature, viz. 25–28° C. (77–82° F.). After the action has commenced, sufficient heat is evolved by the fermentation to maintain this temperature, provided that the external temperature is not too low and that the vat is composed of sufficiently non-conducting material. The retting organism, while rapidly attacking pectic matter, has but little action on the true fibre substance, and the temperature may therefore be allowed to vary within a fairly wide range without affecting the results. Considerable latitude in respect of time and temperature are thus permissible without any serious consequences.

As the retting is effected equally in every direction, very large tanks can be used with a depth up to 11 feet, the number of tanks required and the cost of their construction thereby being greatly reduced. The volume of water employed is from 2,200 to 2,600 gallons per ton of flax straw. About one-half of the water can be used a second time, but it cannot be used for a third operation owing to the accumulation of toxins secreted by the bacillus. The retting takes place with great regularity and occupies the same length of time whatever the depth of the tanks or the quantity of flax straw immersed, so long as the layers of straw do not exceed a total thickness of 10–11 feet. In actual industrial practice it has been found that retting is completed in from 60 to 72 hours, and it is probable that even this period could be considerably reduced.

The Kayser process is employed in a factory of Seine-Inférieure and has given excellent results, the yield of fibre obtained amounting to 14–17 per cent. of the weight of flax straw treated. The method can also be used for hemp and would doubtless prove suitable for certain other fibrous materials.

Sisal Hemp.—An account of the cultivation of Sisal hemp in the French Sudan has recently been given by J. Vuillet, Director of Agriculture in French West Africa,

in *Revue de Botanique appliquée et d'Agriculture coloniale* (1922, **2**, No. 8, 132).

Two species of Agave have been introduced into the French Sudan, viz. Henequen (*A. fourcroides*) and Sisal (*A. Sisalana*). The former was sent to the country in 1899 by the French Consul-General in Mexico, and the latter was derived from some bulbils from Florida which were forwarded in 1902 from the Jardin Colonial to the Agricultural Station at Koulikoro. Planters, however, have confined their attention to Sisal as they state that the Mexican plant grows more slowly than the Sisal agave and cannot be cut until three or four years later than the latter.

The plantations are situated in Upper Senegal at a locality a little below Kayes, where they occupy the greater part of four concessions of 200, 800, 1,000 and 1,200 hectares respectively. A fifth plantation is now being established in the Valley at a point somewhat higher up the river.

The extraction of the fibre is carried out in two factories where American machines of the Prieto type have been installed.

Comparatively little Sisal hemp has hitherto been produced in the French Sudan, but owing to the large extensions which have taken place in recent years a rapid increase in production is anticipated. The output in tons during the years 1915–21 was as follows: 1915, 115; 1916, 229; 1917, 150; 1918, 80; 1919, 100; 1920, figures not available; 1921, 162. The fibre is stated to be of the finest quality provided that the leaves are not cut prematurely.

From the labour point of view, Sisal hemp production offers the great advantage that, especially if mechanical cultivation is adopted, large numbers of workers are required only at the time of cutting the leaves, which occurs during the interval between the native crops. The period in which the fibre is extracted ends just after the rains begin, a little before the Senegal River is in flood, thus permitting the fibre to be conveyed by boats to the sea. This facilitates the exportation of the product which, after being loaded at the plantation, can be transported entirely by water to European ports.

Cotton

India.—*Bombay.*—In the Bombay Karnatak there are two cotton tracts which grow respectively the types of cotton known as "Kumpta" and "Dharwar-American."

In the latter tract, which lies chiefly in the Dharwar district and the adjoining States, about 400,000 acres are planted annually and produce 100,000 bales of cotton. A study has recently been made of this cotton with a view to its improvement, and a paper entitled "An Improved Type of Cotton for the Dharwar-American Tract" has been contributed by G. L. Kottur, B.Ag., to the *Agricultural Journal of India* (1922, **17**, 347).

The Dharwar-American cotton is derived from New Orleans stock which was introduced into the country in 1819. The cotton plants consist of a large number of different types, which vary in hairiness of the leaves, the number and size of the bolls, the lint percentage, and the length and strength of the fibre. The irregularity of the cotton crop obtained from these plants is a serious drawback and depreciates its market value. The cotton is moreover particularly susceptible to the red leaf blight which often causes considerable damage to the crop. The prevalence of this disease has prevented so large an extension of the area devoted to Dharwar-American cotton as would otherwise have taken place.

Selection experiments have been made with a type of the Dharwar-American cotton with hairy leaves, and a strain known as "Gadag I" has been obtained which is resistant to the red leaf blight, produces large bolls, and gives a better yield, a larger ginning percentage and a more uniform fibre than the ordinary crop. The following figures show the comparative yield per acre of seed-cotton and lint, and the ginning percentage of Gadag I cotton, with average ordinary Dharwar-American grown side by side for a number of years on the Gadag farm.

	Yield per acre. Seed-cotton.	Lint.	Ginning percentage.
	lb.	lb.	
Gadag I.	460	159	34·0
Dharwar-American	390	121	29·3

The purity of Gadag I is being carefully maintained on the Dharwar farm and seed is being distributed to growers, with whom it is in considerable demand. The cotton is readily purchased by merchants and mill-owners at prices much in advance of those paid for the ordinary cotton.

Attention is being directed towards effecting a still further improvement in the cotton of the Dharwar-American tract.

United Provinces.—In 1919 an account was given by B. C. Burt, Deputy Director of Agriculture, Central

Circle, United Provinces, and Nizamuddin Haider, of the Subordinate Agricultural Service, United Provinces, of experiments carried out on the improvement of Cawnpore American cotton by pure line selection (*Bull. No.* 88, *Agric. Research Inst., Pusa*). It was pointed out that when Cawnpore-American is sown sufficiently early and irrigated, it gives an average yield at least equal to that of the ordinary " desi " cotton grown under similar conditions, and that the cotton is more valuable than that of the latter kind. It was also shown that, as the cotton can only be sown within a limited period, special arrangements for irrigation must be made, but that if this were done and suitable organisation for marketing were available there was little doubt that the Cawnpore-American cotton could be profitably grown in some of the canal districts of the United Provinces. It was observed that the field crop of this cotton was a mixture of different races of very varying value. A number of these races were isolated and the best of them proved on cultivation to be superior to the field crop in yield per acre, ginning percentage and uniformity of staple.

This work has been continued and a further report by B. C. Burt (now Secretary of the Indian Central Cotton Committee) has been issued as *Bull. No.* 126 (1922), *Agric. Research Inst., Pusa.* The field trials of the different selections have now been completed and spinning tests have been carried out. One of the selections, known as " Ca 9," has been finally chosen for distribution and a definite stage has been reached in its cultivation in the Cawnpore District. A special system of canal irrigation has been tried for three years with satisfactory results, and a market for the cotton has been established which is independent of the price of the desi cotton and is governed solely by the Bombay prices for cottons of good staple.

The " Ca 9 " cotton gives a good yield per acre which is superior to that both of the desi cotton and of the unselected Cawnpore-American. The ginning percentage is about 31 and the length of staple $1\frac{1}{16}$–$1\frac{1}{8}$ in. Spinning trials have shown that it is suitable for 25's warps and 30's wefts in Cawnpore and up to 36's in Lancashire. Over 1,100 acres were planted with this selection by cultivators in 1920 and sufficient seed is now available to replace the original Cawnpore-American entirely.

Australia.—In the *Queensland Agric. Journ.* (1922, 17, 273) an account of cotton cultivation in Queensland is given by H. C. Quodling, Director of Agriculture. It is stated that the Government is showing great interest in

the crop and, with a view to the encouragement of farmers and the establishment of the industry, has undertaken to make an advance of 5½*d.* per lb. on seed-cotton and to gin it on the owner's account. This rate has been guaranteed until June 30, 1923. Many farmers are now growing cotton and have found it a very profitable crop. The production for the year 1921–22 will probably exceed 1,500 tons of seed-cotton and a large extension is expected in 1922–23. The Australian Cotton Growing Association (Queensland) has established modern ginning factories at Rockhampton and Brisbane (Whinstanes) and by its active participation is contributing greatly to the success of the industry.

The Department of Agriculture is endeavouring to promote the cultivation of improved long-stapled Upland varieties which will give good yields of cotton of high commercial value.

United States.—*Cotton Seed for Sowing.*—The average area annually devoted to cotton cultivation in the United States is about 35,000,000 acres, and for planting this acreage approximately 500,000 tons of seed are required. It is estimated that 30 per cent. of this quantity is obtained by farmers from commercial sources, the remaining 70 per cent. being produced on the farms where it is used. In view of the importance of the quality of the seed to the cotton-growing industry, an article on "Marketing Cotton Seed for Planting Purposes," prepared by J. E. Barr, Investigator in Marketing Seeds, has been issued by the United States Department of Agriculture as *Bulletin No.* 1056 (1922).

The average commercial cotton seed at present used for planting is not of a high standard owing to improved methods of preparing, storing and marketing having been overlooked or neglected. An ideal cotton seed is described as seed selected from a pure cotton which is true to type, well matured, free from diseases and pests, recleaned and graded, and with a germinating power of not less than 88 per cent. The more thorough and uniform removal of surplus lint and extraneous matter, including small or light inferior seed, would probably result in a reduction of 100,000 tons of cotton seed in the annual requirements of the United States and a saving of 30,000,000 lb. of linters which are at present wasted. The process of de-linting ensures more rapid and uniform germination with less seed per acre. Recleaning and grading result in the production of clean seed, of uniform weight and containing a relatively larger quantity of nutritive

constituents. Cotton seed stored in sacks should be so stacked as to permit ventilation, as otherwise heating is liable to occur, which seriously impairs the germinating power. Sales of cotton seed should be made on the basis of the results of reliable germination tests. The registration, inspection and certification of cotton fields from which seed for planting is to be selected would assist in the provision of a commercial supply of cotton seed of pure variety and true to type, but would not reduce the need for de-linting, recleaning and grading and insisting on the highest possible germinating capacity.

In connection with this question of cotton seed for sowing, attention may be drawn to *Department Circular* 205 (1922), *U.S. Dept. Agric.*, on "Cotton Seed Mixing Increased by Modern Gin Equipment" by W. W. Ballard and C. B. Doyle. This publication gives an account of tests which have been made to determine the amount of mixing which takes place at public ginneries when one variety is ginned after another. The results show that the extent of mixing which occurs in this way has not been fully appreciated and that it has greatly increased in recent years with the use of more modern ginning equipment. The causes of the mixing are fully explained in the *Circular* and means are suggested for reducing it. In view of the difficulty in avoiding the mixing of seed at the ginneries, it is pointed out that the most practical way of maintaining pure seed supplies is for farmers in particular districts to grow one and the same single variety so that only one kind of seed will be handled. The value of one-variety communities of this kind has already been demonstrated in the Salt River Valley of Arizona where the Pima variety of Egyptian cotton is exclusively grown.

Irrigation of Pima Cotton.—In 1912 American Egyptian cotton was first grown on a commercial scale. The cultivation of this cotton has since developed to such an extent that it is now one of the principal crops of Arizona and parts of California. In 1920 about 250,000 acres were planted with it in the States mentioned, and the area devoted to the Pima variety in the Salt River Valley greatly exceeded that of any other crop.

In 1918 an investigation was begun to ascertain the practicability of using soil-moisture determinations as an index of the water requirement for growing Pima cotton and was continued throughout 1919. It was hoped that definite information would thus be gained which would be of value in determining the best methods of irrigation for the crop. The plan adopted was to apply

water so as to keep different amounts of moisture available at various depths of the soil and to study the behaviour of the plants in response to the different proportions of soil moisture, in order to learn the quantity of water which would give the best development of the crop. The results of this work have now been published in a paper entitled, " Water-stress Behaviour of Pima Cotton in Arizona," by C. J. King, of the Office of Biophysical Investigations, which has appeared as *Bull. No.* 1018 (1922), *U.S. Dept. Agric.*

The following are some of the principal conclusions reached as an outcome of the investigation.

The normal growing season in the Salt River Valley, where the experiments were made, is only just long enough for the full development of the Pima cotton plant, and care is therefore required in choosing a suitable date for sowing and in keeping the plants in full activity during the limited time available for boll production. Occasionally, the occurrence of severe frosts at the beginning of November has caused considerable damage to the late crop of bolls.

The average period of ripening of the bolls was found to be 68 days, but the early bolls mature much more rapidly than those formed later.

Plants which produce the greatest amount of vegetative growth suffer most frequently from " water stress," remaining longer in a wilted condition between irrigations and showing an earlier recurrence of wilting after irrigation. This is apparently due to the fact that there is no appreciable difference in size or distribution between the roots of large plants and small plants.

The severe water stress and the shedding of bolls occurring in the case of plants possessing large areas of leaf surface are not always caused by a lack of available moisture throughout the soil, but may be due to a reduction of the moisture in the soil immediately surrounding the roots at a more rapid rate than it can be restored by capillarity.

Plants to which irrigation water was supplied soon after the flower buds began to form, and frequently afterwards, produced a greater growth of stem and a larger number of flowers during the first 45 days of flowering than plants to which water was not supplied until 16 days later. Plants supplied with water sparingly throughout the season bore a greater number of bolls late in the season than plants provided with larger quantities of soil moisture.

In general, the results of this investigation indicate that an effort should be made to stimulate the setting of

fruit to the fullest extent during the months of July and August, especially in areas liable to early frosts, since the number of bolls set during this period largely determines the size of the crop.

Guatemala.—According to a report by H.M. Vice-Consul in Guatemala City (*Board of Trade Journ.*, 1922, **109**, 47), special attention is now being devoted to cotton cultivation in Guatemala. Hitherto the crop has been grown only on the Pacific slope around Mazatenango where a native long-stapled variety is cultivated. The cotton is ginned in a new factory at Mazatenango. The whole of the produce is at present used locally, but it is anticipated that in the future there will be a small surplus for export.

A Jugo-Slav planter has recently planted an area of about 270 hectares (600 acres) on the Atlantic slope at La Reforma, near Zacapa. He has also prepared 1,000 hectares for cultivation and has erected a ginnery on the estate. The plantations are on alluvial soil near the Montagna River. It is reported that a crop of 600 metric tons of long-stapled Peruvian cotton is being produced this season. The climate of the Zacapa district is well adapted for cotton cultivation, but owing to the scarcity of labour no great development can take place until the restrictions on the importation of coloured labour are relaxed.

It is understood that a Manchester firm is undertaking experiments in Guatemala with Egyptian Sakellaridis cotton.

FORESTRY AND FOREST PRODUCTS

Tree-repairing.—A concise, well-illustrated account of the methods employed in repairing damaged trees planted for ornament or shade is given in *Bulletin No.* 73, 1922, *Forestry Branch, Dept. of the Interior, Canada.* After a short description of the general internal structure of a tree and the causes of decay, instructions are given regarding the removal of branches, the treatment of wounds by trimming, shellacking, disinfecting and waterproofing, the repair of cavities and the bolting and guying of limbs. It is pointed out that the following fundamental principles must be observed to secure the best tree-repair work; (1) All diseased, decayed, injured or dead material must be completely removed from the tree; (2) all cut surfaces must be sterilised and then made waterproof; (3) deep cavities must be covered or filled and left in such a condition that they will heal readily; and (4) the tree must

be kept under observation and immediate attention given to any defects that may appear in the repair work and to any new injuries which may be received later.

Sitka Spruce.—The Sitka or Tideland spruce (*Picea sitchensis*, Trantv. and Mey.) is one of the most important timber trees of British Columbia (cf. this BULLETIN, 1920, 18, 197). The timber came into great prominence during the war owing to its special value for the construction of aeroplanes. A detailed description of the tree, its geographical distribution, climatic and soil requirements, reproduction, growth and management, and the characteristics and uses of the wood are given in *Bulletin No.* 1060, 1922, *U.S. Dept. Agric.* The tree occurs within a zone, never more than 200 miles wide, along the North Pacific Coast from Alaska, where it constitutes almost the sole timber cut, to Northern California. The total stand of timber is estimated at from 40 to 44 billion feet board measure, of which more than one-third occurs in Alaska, one-third in British Columbia, and the remainder in Washington, Oregon and California. The tree reaches a very great size, comparable with the maximum for Douglas fir. It attains its greatest development in Washington and Oregon, where many trees have been found with a diameter of over 9 ft. at a height of 10 ft. above the ground; the largest one measured was in the former State and was 16 ft. in diameter at breast height. The average height of trees in the virgin forest of these two States is about 230 ft., whilst in British Columbia it grows to heights of 160 to 180 ft. Total heights of 296, 285 and 282 ft. have, however, been recorded for individual trees in Washington.

The wood has a wide variety of uses. In addition to its special value for aeroplane construction, due to its light weight, combined with strength and toughness, it is unsurpassed for the manufacture of paper pulp, either by the mechanical or chemical process, and is specially suitable for musical instruments. It is also a desirable wood for boxes, crates, barrels and veneer, and is well adapted for light construction work in buildings.

Mahogany.—*Bulletin No.* 1050, 1922, *U.S. Dept. Agric.*, deals with the identification of true mahogany, certain so-called mahoganies, and some common substitutes. A key is given for the identification of the different woods, based on the colour as seen on a freshly cut longitudinal surface of the heartwood, and on the structure as observed on the end surface when cut with a sharp knife. Then

follows a description of the species, including the countries of origin and the physical properties and structure of the wood. Photographic reproductions are given showing the structure of the end grain of each wood under a magnification of 7·5 diameters. The species dealt with comprise true mahogany (*Swietenia* spp.), crabwood (*Carapa guianensis*, Aubl.), Spanish cedar (*Cedrela odorata*, Linn.), Brazilian cedar (*C. brasiliensis*, Juss.), Toon (*C. Toona*, Roxb.), sapele or African mahogany (*Entandrophragma Candollei*, Harms), African mahogany (*Khaya* spp.), Philippine mahogany (*Shorea* spp.), Colombian mahogany (*Cariniana pyriformis*, Miers), Liberville mahogany, African cedar or okoumé (*Boswellia Klaineana*, Pierre), sweet birch (*Betula lenta*, Linn.), yellow birch (*B. lutea*, Mich. f.), red gum (*Liquidambar styraciflua*, Linn.), and white mahogany (*Tabebuia Donnell-Smithii*, Rose). It is pointed out that over 60 different species of timber have at one time or another been put on the market under the name of mahogany. Of these, however, those now most commonly sold under that name in the United States are true mahogany from tropical America, African mahogany and Philippine mahogany. The Cedrelas are rarely sold as mahogany, whilst crabwood, sapele, Colombian mahogany and Liberville mahogany are imported only in small quantities. Birch and red gum are used principally as acknowledged imitations of mahogany, but sometimes they are used in furniture sold as being made of genuine mahogany.

MINERALS

General

Minerals of China.—Reliable information regarding China's minerals has always been difficult to obtain and as a consequence erroneous and frequently exaggerated estimates have been circulated. According to *Chem. Eng. and Min. Rev.* of May 5, 1922, the Geological Survey of China, which is staffed by efficient men, has been endeavouring to furnish statistical information on the mineral resources of the country. Recently the Survey has issued statements of production which may be regarded as trustworthy, although in some cases they are only approximate.

Coal.—The annual production of coal is estimated at 12½ million tons. This exceeds estimates from other sources, probably because the coalfields of Kailan, Fushun and Pinghsiang have in late years considerably increased their output. The coal reserves have been estimated conservatively at 23,435 million tons, but if the smaller

seams and a greater depth were taken into account it is probable that 40 to 50 thousand million tons would be nearer the truth.

Iron.—The Survey states that nothing has been so much exaggerated as the estimate of the iron resources of China, for which Richtofen was directly responsible. His superficial survey of the extensive Shansi fields gave unreliable results, for subsequent investigations proved that the deposits are too shallow in depth to be of great importance. The known iron ore reserves of China, calculated on a shallow basis, represent about 677 million tons, or, if taken at a greater thickness, about a thousand million tons. On the latter basis China possesses about one-quarter of the reserves of America and four-fifths of those of Great Britain.

The latest available statistics of iron ore production are for 1916, in which year they were as follows:

Total production, 1,338,500; smelted in China, 1,060,000; exported, 278,500 tons.

Antimony.—The antimony deposits of China are the richest known, and one-half of the world's production of antimony comes from that country. According to an investigation made by the Geological Survey, the Hsinkwangshan deposit of Hsinghua, Hunan, alone contains ore equivalent to more than two million tons of pure antimony. This deposit, together with some smaller ones in the same province, produces about 90 per cent. of China's total output. There are other mines in Kweichow and Yunnan.

The demand for antimony has decreased in recent years, and Chinese investigators are seeking to provide a further outlet for the metal by the production of new antimony alloys.

Tin.—After the Malay States and Bolivia, China is the next largest producer of tin. Although primitive methods of mining and smelting are used, Kochui in Yunnan province has produced annually between 7,000 and 8,000 tons of tin or 80 per cent. of the total Chinese production.

Tin is China's most important mineral export. In 1920, 189,940 piculs (11,292 tons), valued at 11,098,167 Customs Taels (£3,768,383), were exported.

Other Metals.—Tungsten was first discovered in China in 1915 and at the present time China is the largest producer in the world. The ores come from Hunan, Kiangsi and Kwangtung, particularly from a field at the junction of all three provinces.

Bismuth and molybdenum ores occur in the southern

provinces, principally Fukien and Kwangtung. Other metals produced in relatively small quantities are gold, about 100,000 oz.; silver, 40,000 oz.; lead, 5,000 tons, and zinc 6,000 tons per annum.

Mineral Production of Ecuador.—According to the United States Consul at Guayaquil the only minerals at present worked in Ecuador are gold, petroleum and salt (*U.S. Commerce Reports*, April 24, 1922, p. 250).

Gold is produced at Portovelo in the southern part of Ecuador, near Zaruma. The control of this mine is based on a contract between the Government and the operating company. The 1921 production was 22,224 lb. of metallurgical precipitate valued at $774,975 (U.S.) and 1,313 oz. of mill bullion worth $4,561. The whole of the products are exported to the United States.

Petroleum is produced from the Santa Elena fields, on the west coast, at the rate, at present, of about 4,000 barrels of crude oil per month, all of which is consumed locally. Petroleum and oil shale have also been located north of Guayaquil, more than 100 miles from Santa Elena.

The salt industry is a Government monopoly. The deposits are found in the region of Payana, Punta Arenas, Salinas, Charapoto, Crucita, Latucunga, Guaranda and the Galapagos islands.

Guayaquillite (an oxygenated hydrocarbon) is found in the Canton of Daule, near the Daule River and occurs over a considerable area. The substance is utilised in the manufacture of explosives. It is a fossil resin with the appearance of an impure wax and occurs in nodules in the alluvial soil along the Daule River, but it is improbable that large deposits exist.

Aluminium

Sierra Leone.—According to the *Rept. Sierra Leone Geol. Survey* for 1921, low-grade bauxites are found near Falaba, Sierra Leone. In outcrops of the norite complex which constitutes the mountain mass of the colony, bauxites of higher quality are found. A sample of decomposed norite taken from a cutting made for a motor road, several hundred yards east of Wilberforce, was earthy in texture and reddish-brown in colour. Analysis showed it to possess the following percentage composition: alumina, 51·08; ferric oxide, 14·41; silica, 9·46; and loss, chiefly water, 25·32.

Asbestos

Australia.—According to the *Indust. Australian and Min. Standard* (April 13, 1922, p. 682), a distinct revival is taking place in working the asbestos deposits of Western Australia. Works have been established near Perth, where short-fibred material is manufactured into useful commodities. Development has hitherto been retarded by lack of capital, the producers being unable to erect proper plant for treatment, but the Department of Mines has been successfully approached with a view to establishing State works, where the raw material will be worked up into marketable products for a reasonable fee. The same department is also willing to make advances upon good quality long-fibred material for shipment abroad. With this State assistance the Western Australian asbestos industry should be able to make considerable progress.

Coal

Union of South Africa.—According to a paper by E. T. Mellor, read, early in 1922, before the Geological Society of South Africa (abstr. *Colliery Guardian*, July 28, 1922, p. 211, and Aug. 4, 1922, p. 272), a number of bore-holes put down in recent years in the Witbank coal-field, Transvaal, have been the means of greatly extending the known coal area, and of enormously increasing the known coal reserves, of that field. In addition to the five seams previously known (see *Imperial Institute Monograph on Coal*, 1920, p. 73), a seam, now known as No. 6, has been found to the east of the old area. It lies from 50 to 60 ft. above No. 5, is from 4 to 5 ft. in thickness, and is remarkable for its bright clean coal, which frequently gives an evaporative power exceeding 13·0. Mellor estimates that at least 1,000 million tons of coal, having an evaporative power above 12·5, have been found by the recent boring operations.

Australia.—The 66-ft. seam of the Clermont area in Central Queensland is referred to in the *Imperial Institute Monograph on Coal* (p. 121). According to Walter J. Morley (*Colliery Guardian*, Aug. 18, 1922, p. 393), this seam of solid coal at Blair Athol in that area is 93 ft. thick, without a clay band. The coal is non-coking and free-burning, and is admirably adapted for boiler and general domestic purposes. The heat value of the coal as delivered amounts to 6,646 calories. A company has, for the last twelve years, been exploiting the seam by the bord-and-pillar system, but it has been recently decided

that the future working shall be by the open-cut method, thereby raising the whole of the coal, and leaving none of it behind as in the bord-and-pillar system. The overburden, which consists of sandstone, is 43 ft. in depth at the point where operations will be commenced, and arrangements are being made for the removal of 90,000 cub. yds. of this overburden. The field, although small in extent, is estimated to contain 400 million tons of coal.

China.—According to the vice-president of the China Institution of Mining and Metallurgy (*U.S. Comm. Repts.*, No. 10, March 6, 1922, p. 577), progress in the basic industries of coal and iron has recently been fairly satisfactory in North China, where conditions have been more peaceful than in South China and Szechwan. Three new companies of some importance are operating in North China: one of them is working mines near Chaoyang in Chihli Province, the seams of which yield an excellent steam coal; another, at Mentowkow, 16 miles west of Peking, owns an anthracite concession; and the third, in North Shansi, has a concession containing both navy or smokeless coal and a high-class steam coal.

Of the old companies in China, the annual output of the Japanese Fushun collieries in Manchuria will, according to present plans, be raised, during the next ten years, from 3 to 8 million tons; and the Sino-British Kailan Adminstration will, within the next three years, increase the daily output from 15,000 to 20,000 tons.

Belgian Congo.—A report on the coal deposits of the Belgian Congo, presented to the recent International Scientific Congress at Liége (*Iron and Coal Tr. Rev.*, July 21, 1922, p. 82), gives some particulars of the deposits at Lake Tanganyika, located in 1910, and of those of the Luena, near Bukama, located in 1914.

At Lake Tanganyika there are at least 5 regular seams, varying from 2 ft. 6 in. to 5 ft. 6 in. in thickness, the total thickness being 16 ft. The seams are worked by adits. The deposits are estimated to represent 1,000 million tons of coal.

The Luena seams, which represent 16 million tons, are rather irregular and overlap; the total thickness is from 19 to 23 ft. According to recent reports, the coal mines of Luena are now producing about 100 tons per day, sufficient at present for the needs of the Union Minière and the Katanga Railways. It is hoped to increase the production shortly to 300 tons per day.

The Congo coal yields, on analysis: fixed carbon, 46–50 per cent.; volatile matter, 34 per cent.; ash, 16–20 per cent.; calorific value, 5,500–6,000 calories. It is possible to produce coke from the coal by the addition of other coal of a more binding nature, and experiments in this direction have been made with a mixture of Luena and Wankie (Rhodesia) coals.

United States.—The New Salem lignite field of North Dakota has been described by Eugene T. Hancock (*Bull.* 726 A, 1921, *U.S. Geol. Survey*). The valuable beds are confined to the upper 300 ft. of the Fort Union (Eocene) formation. The mean thickness of the beds, of which there are five, is about 3 ft., and it has been estimated that the field contains upwards of 2,000 million tons. One bed of lignite, from 4½ to 6 ft. thick, was mined for a time about half a mile N.E. of New Salem, 240 ft. below which another bed, 19 ft. thick, is said to have been found. The lignite was sold locally, and the average daily output was reported to be 110 tons. The workings were abandoned in the autumn of 1919. Samples from this field showed a calorific value of from 3,585 to 6,870 calories.

The lignite in the western part of the Fort Berthold Indian Reservation, south of Missouri River, North Dakota, has been described by Clyde Max Bauer and Frank A. Herald (*Bull.* 726 D, 1921, *U.S. Geol. Survey*). The Fort Union formation consists here of shale, clay, sandstone and beds of lignite from a few inches to 15 or 20 ft. thick. There are 14 beds each 2 ft. or more in thickness. Two of the beds, most consistent over large areas, are 4 ft. in thickness; the lowermost bed is 8 ft. in thickness. The total quantity of lignite in the Reservation has been estimated to be 8,655 million tons. Up to the present the lignite has been mined only on a small scale and used locally. Lack of transport facilities, together with the poor shipping qualities of the lignite, preclude extensive exploitation.

Copper

Anglo-Egyptian Sudan.—The *S.A. Min. and Eng. Journ.* (July 1, 1922, p. 1483) has reported the existence of an important gold-bearing copper deposit on the Nile-Congo Divide in the Sudan. An area of 200,000 sq. yds. is covered by native workings on this deposit, which is described as a replacement in porphyry. The ore near the surface is auriferous malachite, but geological opinion is that the primary ore was sulphide and that sulphide minerals will be found at depth. The lodes reach widths as much

as 20 ft. and assays of the lode material have shown up to 42 per cent. of copper and nearly 11 dwts. of gold per ton. The copper-gold mineralisation has been found at different points over a length of 40 miles.

Union of South Africa.—According to *S.A. Min. and Eng. Journ.* (July 1, 1922, p. 1479), an important discovery of copper ore has been made at Artonvilla in the Transvaal. Three ore-bodies have been located at a depth of 200 ft. from the surface and a company has been formed to work them.

In the same issue of the above journal (p. 1480) is reported a strike of copper ore in a borehole on Carblusberg West, about six miles from the well-known O'okiep copper mine in the Cape Province. At a depth of 239 ft. below the surface, the bore intersected 58 ft. of ore averaging about 6 per cent. of copper, including 21 ft. averaging 10 per cent. of copper. Boring is being continued to explore further the extent of the deposit.

Geologically, the prospect of the discovery developing into a new copper mine of the same type as the O'okiep is said to be favourable.

Corundum

Union of South Africa.—Recent developments in the Zoutpansberg corundum field, Transvaal, previously noted in this BULLETIN (1921, **19**, 93), are described by A. L. Hall in *S. Afr. Journ. Ind.* (April 1922, p. 153). The corundum industry in South Africa sprang up at the time when there was an urgent demand for supplies of this abrasive during the war, but primitive methods of recovery were employed, the material exported being simply washed. Post-war conditions have produced changes, and competition with artificial abrasives is now so keen that dressing methods have been completely revolutionised, and carefully prepared and graded grain corundum is being produced. Descriptions and photographs are given of the plant employed, which is much simpler than that used in Canada, being designed on the lines of a cassiterite-concentrating plant. The product, which has a high uniform quality and is free from garnet, magnetite and other obnoxious impurities, can be profitably produced at a competitive price. A wheel made from it passed satisfactorily through severe tests in London recently. It therefore appears that there is an encouraging outlook for this new industry.

Gold

Australia.—The Woolgar gold-field of North Queensland which lies within portions of the counties of Chudleigh and Woolgar, has been described by E. C. Saint-Smith (*Queensland Govt. Min. Journ.*, 1922, Feb., p. 51, and March, p. 95). Upwards of a dozen reefs have been worked here, more or less superficially, for some years, but only one claim is being opened up at present; a few others would appear to be well worth a further trial.

In this region ancient auriferous strata, possibly of Cambrian age, are intruded by dykes of diorite and pegmatitic granite. The claim, known as Perseverance Try Again, has been worked to a depth of 74 ft. A quartz lode, from 2 to 5 ft. in width, striking N.N.E. and dipping 40° to the westward, is being opened up. The vein carries galena in seams, especially along the footwall side, as well as pyrite and some chalcopyrite. An average sample gave: gold 39 dwts., and silver 26 dwts. per ton. Previous to October 1909, 449 tons of ore raised from this line of reef yielded 348 oz. of gold. The Roman Crown (or Red) reef strikes E.N.E. and dips S. 80°. The country rock consists largely of granite in the form of a dyke, chloritic schist occurring to the east. The minerals are galena, pyrite and a little blende. There has been a production of 1,065 oz. from 1,419 tons of ore, or an average of slightly over 15 dwts. per ton.

The Bell Brandon Spring Reef strikes E.-W. and dips flatly to the north in ferruginous schist intruded by pegmatitic dykes. The vein is a wide one of quartz, but only the central portion for a width of 2 ft. is mineralised. The vein carries galena, some cerussite and traces of malachite, and is much stained with manganese. A sample of material, 2 ft. in width, exposed here, yielded: gold, 6 dwts. and silver 1 oz. per ton.

New Zealand.—Some years ago it was reported by James Mackintosh Bell and Colin Fraser ("The Geology of the Waihi–Tairua Subdivision, Hauraki Division," *Bull.* 15, 1912, *New Zealand Geol. Survey*, 125) that in the Waihi district a fairly large boss of dacite of rather irregular shape had intruded an earlier-formed complex of rudely-bedded dacitic lava-flows; and it was considered probable that the whole of the vein-formation and ore-deposition at Waihi owed its origin to the existence of this dacitic intrusion. At a later date, A. Jarman (*Trans. Inst. Min. and Met.*, 1915–16, **25**, 3) showed that in the

Waihi Grand Junction Mine, at any rate, there are no intrusives and the productive rocks are all lava-flows which have accumulated under surface conditions; payable ore-bodies may reasonably be expected therefore beyond the limits of the supposed intrusion. A "Preliminary Report on the Resurvey of the Waihi Goldfield," by P. G. Morgan, Director of the Geological Survey, New Zealand, has been published in the *N.Z. Journ. of Sci. and Techn.* (1922, **5**, 109). In this report the conclusions arrived at by Jarman are confirmed, and are applied to the whole of the lode-bearing rocks of the Waihi district. The dacites of Bell and Fraser are now called quartz-andesites. The hypotheses that the primary lode-filling consisted mainly of carbonates, and that most of the lode-material represents filling of open spaces have been disproved. Among the positive results of the resurvey, it is stated that a partly new hypothesis of lode-formation at Waihi has been evolved, which satisfactorily explains many of the observed facts, and to some extent favours deeper exploration, and the policy of lateral exploration to the limits of the propylitised quartz-andesite is shown to be sound. Deeper exploration to perhaps 2,000 ft. is justifiable, and, since the ore-bearing quartz-andesites have a general dip to the S.E., there is a possibility that ore bodies at a greater depth than 2,000 ft. may exist in that direction.

Colombia.—Eric K. Craig, in an article on gold mining in Colombia (*Eng. and Min. Journ.-Press*, March 25, 1922, p. 478) describes the Constancia gold-quartz mine, which is 45 miles south of Pato, near Anorí, Antioquia. Two parallel quartz veins in schist strike E.–W., dip N. 65°, and are separated by a very fine-grained diorite dyke. The hanging-wall vein, worked by the Colombians, was rich and easy to mine. The foot-wall vein is hard, 20 ft. thick in places, and shows three distinct periods of mineralisation. Occasionally the veins cross, forming ore-bodies up to 30 ft. wide, of higher grade than the average. The diorite dyke carries from 0·5 to 1·5 dwts. of gold per ton. Microscopic examination proved that silica, probably gold-bearing, permeated the dyke before complete solidification took place. The walls of the foot-wall vein have been so permeated by the gold and pyrite-bearing silica that it is only by careful sampling that the limits of the ore and waste can be determined. Crosscuts run into the old foot-wall have proved that ore exists for additional widths of 15 ft. The mine has been developed laterally, more than 1,000 ft. on each side of the shaft, and to a depth of 400 ft., with good ore in all the faces. The ore

contains much arsenopyrite, and is roasted before cyanidation.

With regard to the alluvial ground worked on the Nechi River, the two dredges in 1920 and 1921 dug 5,375,000 cub. yds. of alluvial, which yielded 142,000 oz. of bullion.

Iron

Federated Malay States.—In the *Rept. of the Geologist, Fed. Malay States* for 1921, particulars are supplied of some iron ore deposits in the Peninsula.

At Batu Pahat River, Johore, an iron ore deposit is being worked by a Japanese company.

This deposit was visited by the State Geologist early in 1921 on behalf of the Johore Government. The workings are on the Bukit Menai hill, the backbone of which is a deposit of hæmatite with a little other mineral matter trending nearly north and south. The slopes on either side of the hill are covered with débris from the deposit, which is stated to be 10 to 15 chains wide and 40 chains long, but the actual boundaries could not be defined at the time of the visit. The ore is being mined and shipped to Japan. A large hæmatite deposit occurs at the north end of Gunong Panjang close to the high road from Ipoh to Tambun. W. E. Cameron, the mining geologist, reports that there are possibly 2 million tons of ore available above surface drainage level, and 4½ million tons additional within 100 ft. below that level. Two samples taken from this deposit assayed by the Chemist to the Geological Survey showed the following percentage composition :

	No. 1	No. 2
Iron . . .	68·02	68·70
Sulphur . .	0·03	0·013
Phosphorus . .	0·07	0·086
Manganese . .	0·60	0·45

These analyses represent iron ore of good grade, but the deposit is not well situated for transport. Local smelting by the use of charcoal would entail a large destruction of the jungle timber.

Spain.—The following notes on the iron-ores of Galicia, Spain, are from a memoir by Primitivo Hernándoz Sampelayo, recently published ("Criaderos de Hierro de España," tomo 4, "Hierros de Galicia," tomo 1, *Mem. del Inst. Geol. de España*, 1922). The memoir will be followed by another volume containing monographs on the various deposits.

According to Sampelayo, the iron-deposits of Galicia

are Palæozoic or are derived from the Palæozoic. The most important belong to the Lower Silurian; the Cambrian deposits are small and of little importance.

The following are the principal syngenetic deposits (sedimentary): at Villaodrid, province of Lugo, two beds from 10 to 13 ft. in thickness, are mined. They occur in schists and quartzites (Lower Silurian). The ore is hydroxide of iron in rounded masses (*bolas*) at and near the outcrop, and consists of chloritic-carbonated ore lower down. In 19 years, about 1,700,000 tons of ore were raised here, 1,000,000 tons of which were hydroxide (*rubio*), yielding, on analysis, iron 45, silica 12, and phosphorus 0·75 per cent. The Vivero mines, in the same province, are the next most important in Northern Spain. There are two beds, 6½ to 65 ft. thick, of magnetic ore derived from chloritic-carbonated ores. Magnetite is finely disseminated in the ore. The beds which were formerly quarried on the opencut system are now mined on the longwall method. From 1902, the output has amounted to 1,670,000 tons, the possible production being 120,000 tons per annum. There is a Bleichert cableway upwards of three miles in length. The ore carries iron 45, silica 16, and phosphorus 1·35 per cent., and is the most phosphoric of the ores of Northern Spain.

The epigenetic segregation deposits, produced by the circulation of meteoric waters among the Silurian strata, are now of little importance. They were once largely worked by the ancient Galicians, the iron produced being forged into swords, ploughs, etc. The ore usually contains 50 per cent. of iron, and very little silica and phosphorus. The most important of the epigenetic segregation deposits occurring in Cambrian rocks is that of La Caridad mine at Vaamonde, from which about 50,000 tons of oxidised ore have been shipped from Corunna.

Siderite or pure carbonate ores are only found in a few places, viz. at San Miguel de Reinante (syngenetic-Silurian); at Cuevas das Choyas (epigenetic-Silurian); and at El Cairo, near Villaodrid (syngenetic-Cambrian). The bed containing the last is 3½ ft. in thickness, and yields iron 50, and phosphorus 0·7 per cent. and a little silica. It deserves investigation. A deposit of true magnetite occurs at Los Peares in granite.

Sampelayo has made a microscopic study of the oolitic ores. He found *Girvanella* (a species of algal growth) in the oolitic ores of Villaodrid (Lugo) (cf. this BULLETIN, 1920, **20**, 551) and *Radiolaria* and *Briozoaria* in the silicified ores of Sierra de Meira (Lugo). He also found copious deposits of filiform bacteria in the neighbourhood of

the Palæozoic ferruginous rocks of Galicia, and, in connection with these bacteria, was able to prove the rapid formation of ochreous ferruginous deposits from 2 to 6½ ft. in thickness. The rôle played by *Girvanella* in the precipitation of iron in the syngenetic Silurian deposits is not understood as yet, but that bacteria have helped in the formation of the epigenetic Silurian deposits may be regarded as certain; although as yet it is impossible to say what proportion of the ores is due to chemical precipitation and what proportion is owing to biological processes, the author considers the organic phase of precipitation a very important one.

A report by two Spanish Government mining engineers on the iron ore deposits of Granada is quoted in the *Iron and Coal Trades Review* of Aug. 4, 1922. According to this report, these deposits, although containing high-grade ore, are not of large extent. They are found at Huétor-Santillán, Diezma, Colomera, Loja and Algarinejo. None of these has yet been exploited, but six are stated to be worthy of attention, having average iron contents varying from 51 to 67 per cent.

The report states that the profit on working these ores should range from 1·90 pesetas (1*s.* 6*d.*) to 6·55 pesetas (5*s.*) per ton.

Nickel

Canada.—In the *Canadian Min. Journ.* (May 5, 1922) J. G. Cross describes a deposit of nickel-copper ore recently discovered near Shebandowan Lake about 70 miles west of Port Arthur, Lake Superior. Official reports are not yet available, but according to the author the deposit consists of pyrite and a smaller quantity of pyrrhotite containing nickel as polydymite and copper as chalcopyrite, and also about 0·3 per cent. of cobalt. The nickel and copper are on the average about equal in quantity, but there are zones in which either may be present to the exclusion of the other. Other minerals of nickel and cobalt, which are mainly arsenides, have been identified. The massive ore carries from 8 to 12 per cent. each of nickel and copper, and a sample submitted to the Geological Survey of Canada for analysis was reported to contain 0·16 oz. of platinum metals to the ton. The ore-bodies occur as lenses which are connected by veins of ore. These lenses vary from 2 to 20 ft. in width, the length being proportional to the width. The country rock of the district consists chiefly of Keewatin rocks, which make contact with a granite outcrop. The Keewatin near the ore deposit

is a dark green basic schist dipping at a steep angle. Dykes of serpentine, granite and porphyry are found along this contact with which the ore deposit appears to be connected. About a mile to the south is a large area of serpentine with which the ore may be genetically connected, as at the Alexo nickel mine in Dundonald Township near Matheson.

Oil Shales

United States.—Until quite recently, the upper and lower portions of the Green River formation of the Uinta (Colorado-Utah) Basin have been regarded as lacking in commercial beds of oil shale (cf. *Imperial Institute Monograph* on *Oil Shales*, p. 64), but, according to D. E. Winchester (" Factors influencing the Value of Oil-shale Lands," *Eng. and Min. Journ.-Press*, July 8, 1922, p. 63), detailed examination, accompanied by distillation tests, has now proved that there are, in both the upper and lower members, beds of oil shale which are worth consideration.

Sodium Salts

India.—An investigation into the extent and nature of the *reh* salt deposits of the United Provinces, the Punjab and other parts of India, and the commercial possibility of manufacturing soda from them, was undertaken by the Cawnpore Technological Institute, and the results obtained are set forth in two papers by E. R. Watson and K. C. Mukerjee in the *Journ. Indian Indust. and Labour* (1922, **2**, 13 and 211). The *reh* salt is contained in the surface soil, rendering large tracts of land barren of vegetation, for which reason it has been the subject of numerous investigations by the Department of Agriculture. The salt is chiefly composed of sodium carbonate and sulphate, the former usually predominating, but in some places, notably in Bihar, the sulphate (Muzaffarpur salt) is more abundant and has been used for curing hides. The extraction of these salts from the soil has long provided a primitive industry, the products being used in making soap and glass, and for the washing of clothes. In 1917 the Government of the United Provinces started a demonstration factory for the manufacture of soda ash from *reh* salts, which was afterwards leased to a private firm, but the industry was not developed and the enterprise was abandoned, chiefly because the product sold differed from time to time, and did not conform to the uniform composition of European products.

In order to estimate the amount of crude soda available

in the Province, the Etawah area was taken as representative of efflorescent areas, and from it large numbers of samples of soil were collected and analysed. Each sample consisted of 44 lb. of surface soil removed from 1 sq. yard, the depth of soil removed being one inch. In some cases it was found that it would pay to remove a greater amount per square yard. The results of the experiments showed the total estimated weight of crude soda obtainable annually from visibly efflorescent areas in the whole Province to be 7,321,000 tons containing 4,888,000 tons of sodium carbonate.

Methods of producing soda ash of European standard composition, and of making caustic soda and sodium sulphide, are discussed at length with estimated costs, and it is shown that the manufacture of each of these products would be at least as profitable as the manufacture of sulphuric acid in India at the present time.

IMPERIAL INSTITUTE MONOGRAPHS ON MINERAL RESOURCES: SUPPLEMENTARY INFORMATION. PLATINUM METALS, SILVER ORES, TIN ORES, TUNGSTEN ORES

In the following pages a summary is given of recent information relating to the occurrence and uses of Platinum Metals, Silver Ores, Tin Ores and Tungsten Ores, supplementing the information contained in the Imperial Institute Monographs on Mineral Resources dealing with these materials. Similar summaries relating to Chromium Ore, Coal and Lead Ores, and to Manganese Ores, Oil Shales and Petroleum were published in previous numbers of this Bulletin (1922, **1**, 111, 245).

The Platinum Metals

The world's production of platinum, which was phenomenally low in 1918, has since increased to a certain extent owing principally to larger outputs from Russia and Colombia. At the end of 1920 it was reported that dredging operations were on the decrease in the Urals. In 1921 four dredges were in use, and one of the Ekaterinburg refineries was working. Mining, however, was seriously affected owing to the inability of the Soviet organisations to feed the workmen (*Met. Ind.*, Oct. 7, 1921, p. 279). Apart from the revolutionary troubles, it appears that the Ural platinum deposits are beginning to show

signs of exhaustion, and, unless important new fields are discovered, the Russian output may be expected to diminish. On the other hand, Colombia is likely to show an increased production. After ten years of development work, the placer mines of the South American Gold and Platinum Co. on the San Juan River commenced to operate on a commercial basis in 1921 (*Min. and Sci. Press*, Mar. 12, 1921, p. 368), and it is reported that the company now has three large dredges at work. Dredges are at the present time obtaining about 6,000 oz. of platinum per year in Colombia.

The use of platinum in the form of "platinum black" as a catalyst in the hardening of vegetable oils by the hydrogenation process has been extended (*Min. Ind.*, 1920, **29**, 562).

An alloy containing from 60 to 90 per cent. of molybdenum, and 40 to 10 per cent. of tantalum, has recently been patented in the United States. It is claimed that it is suitable as a substitute for platinum in laboratory apparatus, etc. It has a melting-point of 2,000° C., a high tensile strength, is ductile and malleable, and highly resistant to the action of ordinary chemical reagents (*Chem. and Met. Eng.*, Nov. 2, 1921, p. 846).

The average price of platinum during 1920 was about £23 per oz. troy; in 1921 it was about £15 per oz.

There was a good demand for osmiridium and iridium in the early part of 1921 in the United States, presumably in the automobile industry, the price for iridium reaching $325 per oz.

The following are the outputs in troy ounces of platinum metals of the principal producing countries for the years 1919 and 1920:

	Canada. (alluvial).	Colombia.	New South Wales.	Russia.	Tasmania.	United States.
1919	25	35,000 [1]	213	30,000 [1]	1,670	824
1920	17	35,000 [1]	796	35,000 [1]	2,009	613

[1] *Estimated.*

In Canada there were further recoveries reported as follows:

	1919. oz.	1920. oz.
At the Royal Mint, Ottawa	23	15
At Sudbury from matte	87	283
In the United States from Sudbury matte	1,683	1,720

Figures of production for 1919 and 1920 from other countries are not yet obtainable.

Union of South Africa.—The discovery of platinum-bearing dykes of dolerite and gabbro in the Transkei,

Cape Province, has already been referred to in this BULLETIN (1921, **19**, 104). The deposits have been described more recently by E. M. Weston (*Eng. and Min. Journ.*, Nov. 19, 1921, p. 815), who states that assays and pannings taken over very great widths in various places many miles apart show average contents of several pennyweights per ton. The dykes traverse mudstones, sandstones and shales of the Stormberg (Karoo) series. The platinum is alloyed with iridium and other platinum metals, and is also "apparently alloyed with a large proportion of native iron." Too little work has been done as yet to permit of any definite estimates.

Canada.—In British Columbia platinum metals have recently been reported to occur at Moresby Island, one of the Queen Charlotte group. The crude platinum is associated with bornite and chalcopyrite in veinlets in diorite (*Can. Chem. and Met.*, May 1921, p. 148). It has been stated that for a stretch of 250 miles along the Fraser River, and for about 150 miles on each of the tributaries—Quesnel, Mellon and Cottonwood—as much as 75 per cent. of the black sands can be profitably worked for platinum. Tests are said to show that the sands yield from 8 to 40 lb. of concentrate per cubic yard, the value of the contained platinum metals ranging from $40 to $1,200 per ton (G. F. Kunz, *Min. Ind.*, 1921, **30**, 555).

The mineralised area at Howry Creek, Northern Ontario, in which gold, platinum, silver and arsenic are said to occur in commercial proportions, has already been referred to in this BULLETIN (1921, **19**, 89).

Australia.—In Victoria, osmiridium is known to occur near Foster and at Waratah Range, South Gippsland. According to A. McIntosh Reid (*Tasmania Dept. Mines, Geol. Survey, Bull. No.* 32, 1921, p. 98), it is found in the vicinity of Byron Bay, but in such a highly comminuted condition that it cannot be profitably recovered from the black sand in which it is contained. Recent prospecting has shown that the Tasmanian osmiridium is derived from serpentinised peridodite (olivene and bronzite), while the serpentines derived from pyroxenites and gabbros are barren. The deposits occur in pockety accumulations, which are distributed along structural planes in the rock. Large deposits of osmiridium have recently been discovered in the valleys of the larger rivers in Western Tasmania, but the Gordon, or southern division, and the northern field are not considered of much importance.

Chile.—A reference to the beach deposits of auriferous black sand on the island of Chiloe in the south-west of Chile, which contains platinum in places, will be found in this BULLETIN (1921, **19**, 105).

SILVER ORES

The world's production of silver in 1919 and 1920 amounted to 174,517,900 and 171,200,000 oz. respectively, as compared with about 197,000,000 oz. in 1918. In 1919, owing to the cessation of civil war in Mexico, and owing to a decrease of production in the United States, Mexico became once more the world's premier producer with 62,682,000 oz.; in 1920 the production rose to 66,200,000 oz. In the United States the production for 1921 is estimated at 50,364,000 oz. In 1921 the silver producers of that country still received a fixed price of $1 per oz. for their product under the provisions of the Pittman Act, whilst the average price of silver in 1921 in London was only a little over 3*s.* per oz. as compared with rather more than 5*s.* per oz. in 1920. Nevertheless, with the exception of the abnormal period, 1917 to 1920, the 1921 London average price is the highest since 1892, although it did not exceed 43¼ pence per oz. This favourable price has, however, been more than offset by the higher costs of mining and treatment. The result has been reduction of output in, or the closing down of, a number of silver mines proper throughout the world. Copper, zinc and lead have also suffered from the general depression, so that less silver has been produced as a by-product. Hence, although exact figures are not yet available, the world's silver production in 1921 will probably be lower even than that of 1919 or 1920.

The fall in the price of silver has been accompanied by a fall in the value of the rupee, a matter of import to those who trade in the Far East. Further lowering of the price of silver has been brought about by the degrading of silver coin, or by the substitution of paper money for it, in various European countries. Large stocks of silver are still held in India and China. The Bank of China estimates that between 1914 and 1921 an amount of coin was hoarded in China equivalent to a quantity of silver between 75 and 150 million ounces.

Canada.—The Dolly Varden and Wolf mines in the Alice Arm district of the Skeena Mining Division, British Columbia, have been referred to in the *Monograph* (p. 31), and further information on the former is given in an article

by Robert Dunn (*Eng. and Min. Journ.*, Mar. 13, 1920, p. 643). According to this author, ore-bodies occur as replacement deposits along fracture-zones in andesite. The wall-rock has been replaced by quartz accompanied by considerable pyrite and smaller amounts of galena, blende, native silver, cerargyrite, ruby silver, argentite, rhodochrosite, rhodonite and barytes. The lode strikes E.-W., dips N. 45°–70°, and is up to 30 ft. in width. There is step-faulting of the vein, which is probably local. The ore reserves in June 1919 were estimated to be 40,000 tons, averaging 36·4 oz. of silver per ton. In the Wolf claims three veins have been exposed from 10 to 30 ft. in width. There has been active development in both mines recently. On June 10, 1919, the Taylor Engineering Co., according to J. J. Taylor (*Min. & Sci. Press*, May 1, 1920, p. 638), came into possession of the mines, and by the end of that year had shipped ore containing nearly half a million ounces of silver.

An abstract of an article on the Stump Lake silver-ore deposits in the Nicola Mining Division of the Yale district, British Columbia, has appeared in this BULLETIN (1921, **19**, 424). The mines have been recently reopened after being closed down for thirty years.

The ore-bodies in the Premier mine, in the Spider and Missouri groups of mines, and in the Bear River valley, all in the Portland Canal Mining Division of British Columbia, have recently been described by V. H. Wilhelm, and a summary of his article has already appeared in this BULLETIN (1921, **19**, 106).

The study of the geology of the Salmon River district, also in the Portland Canal Mining Division, has been completed and an abstract of the report by S. J. Scholfield and George Hanson has been published in this BULLETIN (1921, **19**, 424).

The cobalt district of Ontario has been described in the *Monograph* (pp. 39–45). In the *Eng. and Min. Journ.-Press* of May 6, 1922, C. W. Knight gives a preliminary account of a re-survey of the geology of the field, which is to be followed at a future date by a full report by the Ontario Bureau of Mines.

The geology, so far as then known, was described by W. G. Miller in 1905, and a fourth edition of this description appears in Part II of the Bureau's Report for 1913. Since that description was prepared the extensive mine workings have disclosed underground conditions not then apparent, but generally Miller's original conclusions have been found correct. His prediction that the greater part of the silver in the field would be found in the Cobalt

series has been verified by the fact that so far that series has yielded about 80 per cent. of the total silver recovered.

Knight draws attention to two points of great importance from an economic standpoint: (1) that the silver is practically confined to a zone limited to 200 ft. above and about 25 ft. below the contact of the Keewatin (lower) and Cobalt (upper) series; and (2) that for some reason not yet discovered no payable silver ore has been found at a greater depth than 800 ft. from the surface. The recognition of the first point is of great assistance in the mining of these deposits, and also indicates that veins barren on the surface, where this is comparatively distant from the contact, may prove highly productive if followed down to the contact zone.

The faults at Cobalt, while sometimes producing conditions favourable for the formation of silver ore-bodies, have been observed in some cases to limit the lateral dimensions of an ore-body, although the vein itself may be continued. It is suggested that the fault-filling may have provided a filter for the silver in mineralised solutions, without having a similar effect on the other dissolved minerals.

An interesting point referred to by Knight, who quotes examples, is that while silver is limited mainly to the Cobalt series, it has been found in the Keewatin, both at the upper and lower contacts with the Nipissing dolerite. He is of opinion that although the Cobalt field has undoubtedly passed its most productive period, it will, as the result of new discoveries of silver-bearing veins, be producing silver for generations to come, and that outlying areas such as Gowganda and South Lorraine have prospects of contributing appreciably to this output.

Cobalt, although the youngest of all the great silver-producing fields of the world, stands fourth in the order of silver produced, its total output up to the end of 1921 being stated at 10,042 metric tons.

According to J. Mackintosh Bell (*Bull. No.* 209, *Inst. Min. and Met.*, 1922, p. 17) silver was first discovered in the district of South Lorraine, Ontario, in 1907. The only property to attain early success was the Wetlauffer, which produced from a single vein upwards of 3,000,000 oz. of silver. The country-rock is dolerite. In the Keeley mine (referred to in the *Monograph*, p. 47), after being reopened in 1913, a deep-seated oxidised zone was discovered, and outstanding results were obtained in 1921. This zone was proved to a depth of 420 ft., and was rich to a depth of 250 ft., but was barren or very low grade below that depth. High-grade ore averages about 2,000 oz.

of silver per ton; the average run of mill ore from the veins, from which most of the high-grade ore has been picked, amounts to 20 oz. of silver per ton. This ore is composed of veinstone with low silver content or of country-rock impregnated with leaf silver and ruby silver, bordering shoots of high-grade ore.

A brief description of the geology and recent developments in the Gowganda Silver Area, Ontario, by A. G. Burrows in the 29th *Ann. Rept., Ontario Dept. Mines* (Pt. 3, 1920, p. 53) supplements the information given in the *Monograph* (p. 45).

The rich silver-lead vein on Galena Creek in the Mayo area of the Duncan Mining Division, Yukon, was referred to in the *Monograph* (p. 48). In an article on the district by G. F. Johnson (*Canadian Min. Journ.*, Dec. 3, 1920, p. 990), it is stated that from one pocket in the mine (the Silver King) about half a million ounces of silver were recovered. The following information on the Mayo area is also given. The development work on the Lookout claim on Lookout Mountain (altitude 3,500 ft.) proves the vein to have a streak of carbonates up to 12 in. in width, carrying very high but somewhat erratic silver contents. A sample shipment of 27 tons of ore sent to the Trail smelter gave returns of 95·6 oz. of silver and 59·4 per cent. of lead. A sample of 1,800 lb. from the discovery tunnel yielded 125 oz. of silver and 62 per cent. of lead. Rich galena was discovered on Keno Hill in July 1919. The veins in places show a width of 15 ft. of solid galena with phenomenally high silver content.

The Keno Hill region has already been described in this BULLETIN (1921, **19**, 425). A paper by C. F. Williams (*Eng. and Min. Journ.-Press*, June 17, 1922, p. 1039) includes the results of some recent developments. Another type of the older E.-W. veins, which are more or less parallel with the strike of the formations, has been found on the north slope of Keno Hill. It contains little or no galena, but carries freibergite with manganese and a little chalcopyrite with high silver contents. The mineralisation follows a greenstone-schist contact as far as developed. Some of the richest ore-shoots have been found in the upper portions of the greenstone and quartzites, where the N.-S. (newer) veins intersect the E.-W. veins beneath a schist capping. Silver occurs in the galena in the form of an isomorphous sulphide and in tetrahedrite, where the silver replaces the copper up to 30 per cent., forming freibergite. There has not been extensive secondary enrichment in the veins of the district, although

small amounts of native and ruby silver were found at a depth of 200 ft. in a N.-S. vein.

The company, known as Keno Hill, Ltd., is developing ten claims. Twelve veins have been exposed, eight of which have produced ore. The veins vary from 6 in. to 5 ft. in width. A first shipment of 2,150 tons of ore assayed 197 oz. of silver and 60 per cent. of lead. The 1922 shipment is expected to amount to 3,000 tons of ore of slightly higher grade than the above. Several other companies are developing claims in the district, and have already shipped ore or expect to do so shortly. So far the veins have only been proved to the depth of a few hundred feet, and nothing has yet been uncovered to assure sustained production for a long period.

Australia.—According to L. C. Ball (*Queensland Govt. Min. Journ.*, Apr. 15, 1921, p. 165), the recently discovered deposit of rich argentiferous galena at Indooroopilly, Queensland, yielded 14,410 oz. of silver in 1920.

In New South Wales, the Broken Hill strike, which lasted eighteen months, caused a great reduction in Australia's silver production, unfortunately when silver was at its highest price.

The silver-lead deposits of East Gippsland, Victoria, have been described by H. S. Whitelaw (*Rec. Geol. Survey, Victoria*, 1921, **4**, Pt. 3, p. 308). At Mount Deddick, a lode from 2 to 6 ft. thick, striking E. 20° N. in granitic rock, consists of crushed country-rock and quartz, seamed and impregnated with argentiferous galena. The footwall for a width of 20 ft. is also impregnated with galena, and is associated with pyrite. About 100 tons of lode material from surface workings are estimated to contain from 30 to 40 per cent. of lead and 17 oz. of silver per ton.

At Gelantipy there is an E.-W. lode with a southerly dip, up to 10 ft. in width, in porphyry, which carries native silver, pyrite, barytes and specular and micaceous hæmatite, with a gangue of well-laminated quartz (footwall half) or quartz and country-rock. A sample crushing of 10 tons of ore yielded 30 oz. of silver and 4½ dwts. of gold per ton.

Honduras.—According to the *Eng. and Min. Journ.* (Dec. 18, 1920, p. 1163), the Rosario group of mines at San Juancito, in the Republic of Honduras, in 1919 produced 1,584,597 oz. of silver and 10,200 oz. of gold from 133,900 tons of ore.

Mexico.—The Sierra Mojada silver-lead mines in Coahuila, Mexico, are described in the *Monograph* (p. 94).

According to S. F. Shaw (*Eng. and Min. Journ.-Press*, Apr. 29, 1922, p. 722), the limestone immediately below the agglomerate or breccia is sheared and broken to a thickness that varies from 1 to 50 ft. The silver-lead ore has been deposited along two or three strata of the limestone, forming a blanket (*manto*) about 3 miles long from E. to W., and from 328 to 574 ft. wide from N. to S. The oxidised silver-lead ore formerly mined in the blanket deposit averaged about 16 oz. of silver to the ton and from 20 to 30 per cent. of lead. Besides the *manto* deposit, there are contact ore-bodies and silver-limestone impregnations, which are not continuous. The siliceous lead ore and the copper-silver ore were deposited with the sheared limestone or in contact with the agglomerate. Later on, copper and silver, dissolved by meteoric waters, were precipitated at lower points in the sheared limestone and along minute fractures, thus forming the silver-limestone impregnations, large tonnages of which have been mined.

The production of ores from the Sierra Mojada district has probably exceeded 3½ million tons of lead ore and 2 million tons of copper and silver-limestone ore. During recent years some oxidised zinc ores have also been mined.

Las Chispas mine, near the town of Arizpe, Sonora, has been described by Fernando Montijo (*Min. and Sci. Press*, July 10, 1920, p. 58). The vein occupies a fault fissure having a N.W.-S.E. strike. There are layers of breccia and tuff about 600 ft. thick, then 200 ft. of felsite-porphyries, followed by 100 ft. of No. 2 breccia, lying upon No. 2 felsite of unknown thickness. A basaltic dyke and a number of minor cross-slips traverse these formations. Native silver, cerargyrite and argentite occur in the upper breccia, and the felsite below it is characterised by argentite, polybasite, stephanite and ruby silver. In addition there are pyrite, a little blende, galena and chalcopyrite. The gangue consists of quartz, clay, very little calcite and fragments of country-rock. The ore occurs in irregular pockets, forming shoots. The limits of an ore-pocket are defined by clay (*caliche*) filling the open spaces in the vein-fissure. This clay is derived from the felspar of the wall-rock, and is regarded as a good indicator for silver. The vein cuts across the cross-slips at an angle of 26°, and in the areas of ore-shoots the ore extends for a few feet along the cross-slips.

A typical analysis of shipping ore gives the following percentages: lead, 0·7; copper, 0·2; zinc, 1·4; iron, 4·5; lime, 1; with silver 350 oz. and gold 2·75 oz. per ton.

The silver district of Guanacevi, Durango, is briefly described in the *Monograph* (p. 94). According to A. T. Benitez (*Eng. and Min. Journ.-Press*, July 22, 1922, p. 139), the older stratified rocks of the district are represented by a conglomerate, which, folded in anticlinal form, protrudes in the centre of the camp. Tertiary eruptive andesitic flows overlie the conglomerate, and are intersected by later dacite dykes. Rhyolite is the most recent rock. In the eastern portion (Guanacevi proper) the country-rock consists of hard andesitic breccia, and the ores are characterised by the presence of copper and lead, and are only moderately rich in silver and gold. In the central region the country-rock is andesite with dacite dykes, and the veins are rich in gold, and, in some instances, rich in silver. In the western region (San Pedro) the country-rock is soft kaolinised andesite, and the veins are rich in silver and poor in gold. Besides veins, blanket deposits (*mantas*) occur in this region along the conglomerate-andesite contact, while pockets (*bolsas*) are found in the conglomerate itself.

Generally speaking, the richest ore-bodies occur at the contact of conglomerate and andesite, especially when the latter is acid and not basic. There are eight systems of veins, each constituting an important zone of fracture. The vein systems appear to converge towards the south-east. The average strike of the veins is N. 10° W. and the dip E. The veins are of the replacement type. The gangue is quartz and silicified andesite. Stephanite is the principal silver ore, except in a few mines in which argentite predominates. Rich shoots carry proustite, pyrargyrite and native silver. The zone of enrichment in the district only goes down to a depth of about 500 ft., although a few high-grade shoots have reached 1,000 ft. The ore appears to average about 60 oz. of silver and 3 dwts. of gold per ton.

From 1836 to 1906, Guanacevi produced ores to the value of 500 million pesos. From 1906 to date the value of the ore produced amounts to 10 million pesos. The ores are well adapted to the cyanidation and flotation processes, but, in order to work the primary ores profitably, there must be railroad communication and cheaper sources of power.

United States.—The Fairhaven silver-lead district of Alaska has been briefly described in an abstract in this BULLETIN (1921, **19**, 107).

Information on the California-Rand silver mine in Kern Co., California, has recently been published by

A. B. Parsons (*Min. and Sci. Press*, Nov. 12, 1921, and following issues) and J. A. Carpenter (*Eng. and Min. Journ.*, July 23, 1921, p. 132).

Horn silver (cerargyrite) was discovered in Kern Co. in April 1919, and within thirty months silver-gold ore having a gross value of 2½ million dollars was produced. The lode of the California-Rand mine—formerly known as the Kelly—is at the contact between schist (probably of sedimentary origin) and granite, with a dyke of granite-porphyry near by. The lode strikes N. 30° E. and dips E. 78°, but near the surface the ore, containing rich flakes and bunches of cerargyrite, is arranged in nearly flat seams or veins. The oxidised ore contains chlorides, oxides and sulphides, with some bromides and iodides, the gangue being relatively pure quartz. Below 150 ft. argentite, pyrargyrite, proustite and stephanite occur, with some pyrite with which gold appears to be associated. On the 250-foot level, a vein 6 to 12 in. thick was found to contain from 200 to 300 oz. of silver per ton. A new vertical shaft is down 500 ft., and a flotation plant is in course of construction.

The Boise Basin district of Idaho has been described by S. N. Ballard (*Eng. and Min. Journ.*, Apr. 10, 1920, p. 881). He states that in that area gold and silver associated with stibnite, blende, and sometimes galena, occur in fissured zones in quartz-porphyry dykes intrusive in granite.

According to H. G. Ferguson (*Bull. No.* 715, *U.S. Geol. Survey*, Pt. 1, 1921, p. 171), the most productive veins on the Mogollon district of New Mexico, which occur in an area over one square mile in extent, follow a lateral series of faults in andesite, rhyolite or other Tertiary flows. The principal mineral is argentite (both primary and secondary) associated with pyrite, chalcopyrite, bornite and a little galena. In a few veins copper sulphides predominate. In the oxidised zone, cerargyrite and native silver occur. Quartz, calcite and a little fluorspar are the gangue minerals. In the Little Fanney mine, the largest producer, ore has been exposed for 2,700 ft. along the strike, and to a depth of 1,200 ft. In the Last Chance mine, another big producer, developments are 4,000 ft. in length and 1,100 ft. in depth.

Abstracts of an article by J. H. M. Crampton (*Min. and Sci. Press*, June 25, 1921, p. 883) on the Silver Horn district of Nevada, and of a report by Adolph Knopf (*Bull. No.* 715K, *U.S. Geol. Survey*, 1921) on the Divide silver district, south of Tonopah, have appeared in this Bulletin (1921, **19**, 425).

According to Adolph Knopf (*Bull. No.* 735A, *U.S. Geol. Survey*, 1922) the Candelaria silver district of Nevada, which was discovered in 1863, had, up to about thirty years ago, produced silver to the value of $20,000,000. The high-grade ore (containing about 60 oz. of silver per ton) was long ago worked out, but an attempt is now being made to utilise the ore of moderate grade (10 to 15 oz. of silver), a considerable amount of which has been left in the mines. The ore-deposits are highly oxidised manganiferous silver veins. The principal veins are enclosed in felsite and argillite (probably Ordovician), which are intruded by serpentine and quartz-monzonite-porphyry. The lodes are from 2 to 20 ft. thick. Sometimes the fissuring was complex, giving rise to a zone, in places as much as 100 ft. wide, within which the ore-shoots were distributed *en échelon*. As many as three shoots, separated by firm solid rock, have thus occurred. There is extensive tourmalinisation in places in the veins. The old workings extend to a depth of 1,353 ft. vertical. The thoroughly oxidised ores do not extend quite down to that depth, although water-level has not yet been reached.

The Candelaria silver deposits are linked in origin with the late Jurassic or Early Cretaceous intrusions of granite, and differ notably from those of Tonopah and Comstock, which are of Tertiary age. They were formed under conditions of higher temperature than the Tertiary veins, as indicated by the presence of tourmaline. The silver ores are highly oxidised, forming a friable aggregate deeply stained by oxides of manganese and iron. No silver minerals are visible, and the silver is present in an unrecognisable form. It may occur, as in the Potosi Mountain, in bindheimite (a hydrous lead antimonate), which is an oxidised product of jamesonite. The unoxidised vein-filling consists chiefly of a manganiferous ferrodolomite containing pyrite, blende and jamesonite carrying only from 1 to 2 oz. of silver per ton.

The Argentine mine (a consolidation of the Northern Belle and Holmes mines) has been the most productive in the district, silver to the value of $15,000,000 having been produced from 1875 to 1893. The reserves are estimated at 381,000 tons carrying 14 oz. of silver per ton. The Mount Diablo mine has yielded much high-grade ore, but the ore left is of only moderate grade. The ore blocked out at the Lucky Hill mine is said to amount to 60,000 tons.

The high-grade ores of the Comstock lode, Virginia City, Nevada, have been examined microscopically by Edson S. Bastin (*Bull. No.* 735C, *U.S. Geol. Survey*, 1922).

The ores studied came from depths ranging from a few hundred to 2,900 ft. The abundant minerals are quartz, blende, galena, chalcopyrite and pyrite. Argentite and gold are present in notable amounts, while polybasite is rare. The examination shows that all these minerals are primary, as there is no evidence that any of them has replaced other minerals or has filled fractures or cavities in them. Enrichment on a scale sufficient to exert any notable influence on the tenor of the ore was noted only in ores obtained less than 500 ft. below the surface, and some ores from these slight depths showed no enrichment phenomena. Thus chalcopyrite has in places been replaced by covellite or by chalcocite, argentite by native silver or by polybasite, and galena by anglesite or by argentite. Hence both primary and secondary argentite and polybasite occur in the Comstock lode to a depth of 500 ft.; below that depth the silver ores are primary.

The Simon silver-lead district of Cedar Mountains, in Western Nevada, is described by Adolph Knopf (*Bull. No. 725H, U.S. Geol. Survey*, 1921). The ore deposits, which were discovered in 1919, appear to be of late Jurassic or Early Cretaceous age and to have been formed in connection with an intrusion of granodiorite and dykes associated therewith. The ore minerals are galena and blende enclosed in jasperoid, pyrite and arsenopyrite. Other gangue materials besides jasperoid are calcite and limestone. Two large irregular chimney-like shoots of ore have been developed at the Simon mine, which are localised along an alaskite-porphyry dyke, striking N.W.-S.E., dipping N.E. 70°, and 30 ft. in thickness. The ore-shoot in the footwall of the dyke crops out at surface, and is composed largely of siliceous gossan with some galena and cerussite, and, in places, considerable plumbojarosite (a basic sulphate of ferric iron and lead). The hanging-wall shoot is not found above the 230-ft. level, the hanging-wall of the dyke down to that level being formed of unmineralised quartz-keratophyre. The mine has been worked to a depth of 555 ft. The dyke has been altered by the primary mineralising solutions. Some quartz has been introduced, and some sericite and calcite were formed therein, as well as blende, pyrite, galena and arsenopyrite. The unoxidised ore of the shoots consists of galena and blende in a gangue of jasperoid, with pyrite as a subordinate constituent.

The ore already blocked out is said to represent 500,000 tons, averaging 8 per cent. of lead, 9 per cent. of zinc and 5 oz. of silver per ton.

F. M. Wichman has described the Ophir mining

district of Utah (*Eng. and Min. Journ.*, Sept. 18, 1920, p. 560). There is an alternating series of shale and limestone beds known as the Ophir formation, which contains five ore horizons, which have been mined to a depth, on the incline, of nearly 2,000 ft. The superficial ores were rich in silver, the principal ore being cerargyrite, but in depth they appear as argentiferous galena, associated with blende, chalcopyrite and pyrite. All the important mines are on, or close to, an anticlinal axis. The ore occurs principally as bedded replacement deposits in limestone, which are in connection with N.-E. fissures, from a fraction of an inch to 5 ft. in thickness. The typical gangue is calcite. The economic geology of the district has been described by Seymour G. Olmstead (*Econ. Geol.*, 1921, **16**, 433).

Bolivia.—Articles have appeared on the silver-tin deposits of Bolivia by W. Myron Davy (*Econ. Geol.*, Sept. 1920, **15**, 463), and by J. J. Singewald, Jr. (*Eng. and Min. Journ.*, Oct. 16, 1920, p. 763). The information given in each case is mainly geological.

Tin Ores

Great fluctuations in the price of tin were experienced in 1920, the lowest and highest cash prices of standard tin in London being £195 and £420 per ton, and the average £296 per ton. In 1921 with less fluctuation—£148 and £211—the average price was £165. In order to take advantage of the high prices of 1920, great efforts were made to increase production, but at the expense of development. Stocks accumulated, and, with falling prices, production was curtailed, and in 1921 a large number of mines were closed down.

England.—In Cornwall the tin mines are deep, pumping costs are heavy, especially with dear coal, and recently the market for the by-products containing tungsten and arsenic has been much reduced. Tin could not be produced at the price lately ruling, and as a result all the mines were closed down by February 1921, with the exception of the Giew, which worked throughout the year, producing 300 tons of 69½ per cent. concentrate (*Mining Journ.*, Jan. 21, 1922, p. 60). A Commission of the Board of Trade reported that tin mining probably would not be profitable if the price of tin were less than £400 per ton.

Federated Malay States.—When the price of tin was falling rapidly at the end of 1920 the Government of the

Federated Malay States, in order to prevent a crisis with the large amount of imported coolie labour, which might have happened with the sudden general closing down of the mines, assumed control of the tin market and became a purchaser at an enhanced value. But the position could not be maintained after February 1921, when about 10,000 tons of tin had accumulated.

The outputs of the years 1918–20 were 37,370, 36,935 and 34,928 tons respectively, of which Perak contributed nearly two-thirds and Selangor nearly a quarter. The use of dredges is becoming more common.

Nigeria.—In this BULLETIN (1921, **19**, 427) is given a summary of a report by J. D. Falconer on the "Geology of the Nigerian Plateau Tin Fields" (*Bull. No.* 1, 1921, *Geol. Survey, Nigeria*). This report contains much information regarding the Nigerian tin-fields not previously published.

In Nigeria, although owing to the low price of tin some mines recently reduced their output and others closed down, the import of concentrate into England during 1921 was higher than that of 1920, the amounts being 7,507 and 7,483 tons respectively (*Mining Journ.*, Jan. 21, 1922, p. 59). The Government royalty has been temporarily reduced.

Southern Rhodesia.—Occurrences of tin ore in nine different localities in the Mabfen River district of Southern Rhodesia have been described by H. B. Maufe (*Bull. No.* 7, 1920, *Geol. Survey, Southern Rhodesia*). An abstract of his report has already appeared in this BULLETIN (1920, **18**, 569). The cassiterite is found in dykes which are characterised by the presence of lithia-mica or lepidolite. Accessory minerals are fluorspar, garnet and topaz. There is also much alluvial tin in various places shed by the disintegration of the outcrops. Detailed investigation of these deposits has not yet been made.

South-West Africa.—In *South African Min. and Eng. Journ.* (Jan. 15, 1921, p. 501) is an article describing the position of the tin-mining industry of South-West Africa.

Since the British occupation, the cassiterite deposits in the Karibib and Omaruru districts have been actively exploited. The Kohero mine, which has produced tin ore for many years, has recently been acquired by a South African company.

A company has recently been formed to exploit tin claims in the Pankwob Mountain about 76 miles north-west of Karibib. At several other places in this area

alluvial tin deposits are being worked and tin concentrate is being shipped to smelters in the Straits Settlements. The origin of the sheet tin in this area is believed to be the Erongo Mountains. Further information on the district appeared in this BULLETIN (1921, **19**, 428).

Primitive methods of concentrating the tin are practised. The lack of an adequate water supply makes it necessary to use dry concentration or "winnowing," which is carried out by Herero women with wooden dishes.

Union of South Africa.—The Mutue Fides-Stavoren tin-fields are described in *Mem. No.* 16, *Geol. Survey, South Africa*, 1921, an abstract from which has appeared in this BULLETIN (1921, **19**, 552). No new mines have been recently opened up in South Africa, but on the other hand the Stavoren, Lieupoort and Rooiberg mines have been closed down (*Min. Ind.*, 1920). A strike of good ore was made in 1919 in the Zaaiplaats mine at an incline depth of 2,500 ft., and recently the mining of alluvium was begun there also. The outputs of tin concentrate of the Union for the years 1918 to 1920 were 2,206, 1,630 and 2,463 short tons.

The existence of tin deposits near Kuils River, Cape Province, has been referred to in the *Monograph* (p. 52). Additional information is given in a recently published paper by A. V. Krige ("The Nature of the Tin Deposits near Kuils River, Stellenbosch District, and their Relation to Other Occurrences in the Neighbourhood," *Trans. Geol. Soc. South Africa*, 1922, **24**, 53).

The alluvial tin-ore bed worked on Langverwacht has an overburden 8 to 15 ft. in thickness. In the lower part of the deposit cassiterite occurs in small grains averaging $\frac{1}{16}$ in. diameter. Higher up, larger fragments are not uncommon. Cassiterite also occurs enclosed in angular fragments of white vein quartz which may also hold wolframite and tourmaline. These alluvial deposits were evidently derived from the destruction of lodes.

At Kuils River there is a number of lodes and barren quartz veins in granite near the Malmesbury Series (slates), the lodes being restricted to a very narrow zone 200 to 300 yds. in width. The main lode, which has been traced for more than $1\frac{1}{2}$ miles, strikes N. 20° W., and dips E. 30°–35° at and near the surface, but becomes much steeper in depth. The lode varies from 10 in. to 3 ft. in thickness. At a depth of 185 ft. the lode is 5 ft. wide, but is poorer than above. The minerals at Kuils River are cassiterite, wolframite, löllingite, arsenopyrite and

chalcopyrite, with traces of molybdenite, tourmaline, apatite and zircon, chlorite and sericite. At Helderberg, about 10 miles S.E. of Kuils River, are six lodes running from 10° to 30° W. of N. in granite (intrusive). The zone is half a mile broad and the chief minerals are practically identical with those at Kuils River. The same may be said of the Koeberg region, 10 miles N.W. of Kuils River, where the lodes are typical saddle-reefs in the Malmesbury Series (slates). In every case arsenopyrite is plentiful, the abundance of sulphide ores is characteristic and the absence of fluorine-bearing minerals is remarkable. It is therefore not improbable that all these deposits have originated from one and the same magma. According to Krige, the order of crystallisation is as follows: (1) wolframite; (2) cassiterite; (3) arsenopyrite; (4) tourmaline; (5) quartz. Wolframite occurs in higher zones than the cassiterite. In the main lode at Kuils River, it is practically limited to the upper 100 ft. of the lode, and below 150 ft. chalcopyrite becomes prominent at the expense of cassiterite.

Much development work has been done on the main lode at Kuils River. The average yield of a number of samples amounted to nearly 3 per cent. of tin over a stoping width of 3 ft. Operations on the mine have been suspended owing to want of capital.

The barren quartz veins, which occur in all three localities, cross the lodes and average from 4 to 12 ft. in width. They were probably formed subsequently to the lodes.

Krige is of opinion that the lodes were formed from solution, and that the sublimation theory of the origin of cassiterite is inapplicable to them.

Canada.—The deposits of tin ore in Canada so far explored have not proved important, but a tin deposit recently discovered near West Hawk Lake and Star Lake in Western Ontario, described by J. S. de Lury (*Canadian Min. Journ.*, June 25, 1920, p. 520), appears to be worthy of note. The ore minerals are found in schistose rocks bounded on all sides by intrusive granite, probably the source of the minerals.

Pegmatite dykes, apparently offshoots of the granite, are found in the schists, generally in the neighbourhood of the granite contact. These dykes carry molybdenite as the chief economic mineral. In quartz veins, gold, native bismuth, bismuthinite, molybdenite, arsenopyrite and chalcopyrite are found, but no tin. The tin occurs in sulphide-bearing zones in the schist, of which the most

abundant sulphide mineral is pyrrhotite; other sulphide minerals are arsenopyrite, blende, galena, chalcopyrite, scheelite and small quantities of stannite. Samples from the sulphide zone mostly assay less than 1 per cent. of tin. No cassiterite has been observed in this area.

Australia.—In a report by L. F. Harper (*Min. Res.* No. 29, 1919, *Dept. Mines, New South Wales*) are given the results of a recent examination of the Ardlethan tin-field (cf. *Monograph*, p. 64), which is in the parishes of Warri and Ramsay, Bourke Co., New South Wales, and is the most important in the State. The geological formation is fully described. The ore-bodies may be divided broadly into deposits *in situ* and deposits of shed tin. The first type consists of "bungs," pipes and irregularly shaped bunches or lenses; impregnated zones containing finely disseminated cassiterite; face tin deposited upon joint faces of the altered granite; and veins of tin-bearing material, mostly silica, deposited in fault planes and along parallel zones of stress. The second type, referred to locally as "alluvial ground," is found only along the drainage system of the district, and from this source much tin has been recovered. The principal source of tin, however, is the first type of deposit. The ore is dressed to a concentrate carrying about 60 per cent. of tin.

The Carpathia mine, which is the largest in the field, yielded up to the end of 1920, 21,805 tons of ore valued at £214,000.

The alluvial tin mines of Tingha, New South Wales, are described in the *Monograph* (p. 62). An article by J. W. Archibald on the tin resources of Tingha has appeared in the *Indus. Australian and Min. Standard* (Feb. 23 and Mar. 2, 1922), in which the costs of mining and dredging in that district are given in full.

It was reported in the *Queensland Govt. Min. Journ.* (Mar. 15, 1919, p. 117) that a promising tin lode had been discovered at Newstead, Elsmore, Queensland, and also a rich lode 30 in. wide at Long Gully.

Tin mining in Queensland has of recent years been carried on with great difficulty. To assist the industry the Government in October 1919 bought the tin-dressing plant and smelter, with 14 miles of railway, of the Irvinebank Co., North Queensland, with the object of using it as a custom plant. After a loss of nearly £29,000 the plant was shut down owing to the low price of tin.

A recent report by J. P. L. Kenny (*Rec. Geol. Survey, Victoria*, 1920, **4**, 160) describes the ore deposits at the Royal George mine at Mitta Mitta and some newly dis-

covered tin lodes at Dean's Creek, Bogong, Victoria. The Royal George mine is at the head of Diggers' Creek, about 5 miles N.W. of Mitta Mitta township, the lode outcrop crossing the saddle of the spur between Diggers' Creek and Scrubby Creek. This outcrop ranges from 1 to 15 ft. in width, and can be traced for a length of 450 ft. The lode is lenticular, and cassiterite is irregularly distributed in it in rich patches. To the east are two other lodes about 25 ft. apart, each 2 ft. wide. These also contain rich patches of ore. The ore in sight is small in amount, and insufficient prospecting has been done.

At Dean's Creek, Bogong, 6 miles S.E. of the Royal George mine, Kenny discovered six tin-bearing lodes at an elevation of 3,000 ft., but in an easily accessible position. The principal lode can be traced by surface specimens of ore for a distance of three chains. The outcrop is 12 ft. wide and its tin content is high.

The tin deposits of Cooardy, about 20 miles N.N.W. of Cue, Western Australia, are stated by A. Gibb Maitland (*Min. Handbook, Western Australia, Geol. Survey Mem.* No. 1, 1919, p. 6) to be of " a highly promising character." They cover an area of about 4 miles by 1 mile, which is made up of greenstone- and granite-schists much crushed and altered, traversed by a series of pegmatite dykes, some of which are tin-bearing. Large cassiterite crystals occur here and there in the dyke mass, and in certain parts they have more or less segregated in floors and seams. Average samples from these richer portions yielded up to 1·90 per cent. of tin, while detrital matter from the lode, after the removal of all pieces obviously containing tin, yielded 5·9 per cent. of cassiterite and about 6 per cent. of wolframite containing a little scheelite.

Production has recently been confined to the Greenbushes and Pilbara fields: the output is decreasing, that of 1920 being 243 tons, of value £49,449.

A paper by J. G. Weston-Dunn on the Mount Bischoff tin deposits, Tasmania (cf. *Monograph*, p. 71), has recently appeared (*Econ. Geology*, 1922, **17**, 153). Weston-Dunn, following H. Herman, shows that the so-called detrital or residual deposits in the " faces " or large open cuts at Mount Bischoff are in reality lode material of a peculiar nature *in situ*, and, although agreeing with Herman that the greater part of the stanniferous deposit is a product of the alteration and replacement of the porphyries, he believes that the slate and sandstone country and some old igneous basic rocks have also played a part in the tin deposition.

The Giblin tin lode, of the same district, has been

described by C. W. Gudgeon (*Trans. Inst. Min. Met.*, 1919, **28**, 123).

China.—A paper read recently before the Institute of Marine Engineers by W. Semple (abs. in *Iron and Coal Trades Rev.*, Oct. 14, 1921, p. 543) gives a description of tin mining in China.

The mines are either in the mountains or the adjacent valleys. Originally only alluvial tin deposits were mined, but now lode mining is important. Inclined tunnels, which might almost be regarded as shafts, the sectional dimensions of which are about 4 ft. square, have been driven from 2,000 to 4,000 ft. into the mountains. The miners enter the workings provided with a native-made pick and a sack in which to collect and carry out the ore. A loaded sack weighs about 130 lb. and an average day's work for a miner is to mine and carry out to the surface four such sacks of ore. The ore is crushed by native methods and is hand-washed to remove gangue. It is then smelted in furnaces of about 1 ton capacity, constructed of mud brick. A crude home-made blower is used and the smelting operation occupies from 8 to 10 hours.

The refining works referred to in the *Monograph* (p. 86) have a capacity of 1,000 tons of ore per day.

According to the *Chamber of Commerce Journ.* (Oct. 28, 1921, p. 310), shipments of tin from Hong-Kong during 1920 amounted to 10,868 long tons against 8,332 in 1919. From a revenue point of view the export of tin in 1920 was satisfactory, but commercially the prices obtained were disappointing. This, with the high rate of exchange, has had a harmful effect on the industry. Irregular output owing to crude methods of treating the ore have also been prejudicial.

In *U.S. Comm. Rept.*, No. 67, 1920, p. 1596, it is stated that only the trade in the metal between different Chinese ports has prevented complete collapse of the industry, and it is probable that before long local importers will realise that tin can be purchased from the Straits Settlements and some other parts of the world more cheaply than Chinese-produced tin. So far as resources are concerned, the opinion is expressed that the Yunnan field could supply one-fourth of the world's requirements.

Indo-China.—In the *Monograph* (p. 88) the tin deposits of Indo-China are briefly mentioned. Further information from the *Far Eastern Review* (abs. *Mining Mag.*, Apr. 1920, p. 246) can now be added. The tin ores, in most cases associated with tungsten minerals, originate in the

granite massif of the Pia-Oac about $6\frac{1}{4}$ miles from Nguyen-Binh, and 35 miles from Cao-Bang in the far north of Tonkin Province, approximately 124 miles from the nearest railway point at Dong-Dang.

Prior to French occupation the Chinese worked the tin gravels and, to a slight extent, the cassiterite-wolframite lodes. The massif of the Pia-Oac, 6,330 ft. high, is a granulite, which has pierced older schists, and the best mineral veins are found in the schists at the contact. Smaller mineral veins occur in the granulite, sometimes numerous enough to form a stockwork.

The Étain et Wolfram du Tonkin Co. works about twenty veins, the largest of which is 20 in. wide and about 660 yds. long, and has been proved to a depth of 328 ft. The ores as mined are hand-sorted, the middling being recrushed and concentrated, and the mixed product magnetically separated. The tungsten concentrate carries 70 to 75 per cent. of tungstic oxide, and the tin product about 30 per cent. of tin. The output of concentrate has been about 245 tons yearly, but an increase is expected after the installation of a hydro-electric plant at Ta-Sa.

Other mines are being worked at the Pia-Oac, one of which contains a stockwork and débris rich in mineral. The output of this mine is about 50 tons of rich ore annually.

In the valley of Thien-Tuc is an alluvial deposit of fragments of rock split off from Pia-Oac and embedded in a sandy or clayey material. The quantity of this débris has been estimated at more than 13 million cubic yards. It contains cassiterite in amount from 6 to 60 lb. per cubic yard and is about to be worked with a washing plant designed to treat over 300 cubic yards daily. A smelting plant is also to be erected, and the use of electric furnaces is being considered.

The alluvial deposits are at various horizons and are being worked by the Société des Mines d'Étain du Haut Tonkin. The lowest deposits are heaps of rubble and consist of granulite fragments embedded in a sandy clay. The clay is disintegrated by water jets, and the contained cassiterite is recovered in sluices.

Japan.—The information in the *Monograph* (p. 89) on the tin deposits of Japan has been supplemented by J. M. Hill (*Eng. and Min. Journ.*, May 1, 1920, p. 1017). The tin-producing localities in Japan are stated to be: (1) near Kagoshima, Satsuma, on the south island; (2) in Tajima Province about 50 miles north of Kobe; (3) near Nayegi. The Akinobe mine in Tajima Province was

developed as a copper mine, but in 1912 tin and tungsten minerals were found in the ore. In this mine the veins are in slates and quartzites, which are intruded by diorites. It is reported that in 1917 the daily output was 42 tons of tin and tungsten ore.

A small smelter at Ikuno produces about 250 tons of metallic tin per annum from concentrate.

The Susuijama mine in Satsuma produces tin from veins in shales and sandstones that also carry lead and zinc. Apparently the output is both smelted and absorbed locally.

Russia in Asia.—According to *U.S. Comm. Rept.*, No. 108, 1919, p. 734, tin is found on the River Ono in the Transbaikal and in the Kirghiz Steppes.

Belgian Congo.—According to *L'Afrique Française* (June 1920, p. 215), the tin-mining industry of Katanga is being actively developed.

L'Union Minière is exploiting a mine at Busanga between Ruwe and Bukama. The monthly output of tin is about 50 tons of concentrate with a tin content ranging from 65 to 75 per cent. In the district of the Tanganyika-Moero, the mines of Manano and Kitobola in the valley of the Luvua continue to be worked. They first produced tin concentrate in 1917 at the rate of 10 tons a month, but lately the output has been about one ton per day.

In the same region another company has explored the Minka deposits, which are now being worked on a small scale.

In the Lukushi and Kikondja districts, Lualaba Valley, several hundred tons of tin concentrate have been produced and exported.

Morocco.—According to *La Metallurgie* (abs. in *Mining Journ.*, Jan. 21, 1922, p. 43) important lode tin deposits have been discovered in the Oulines region, about 75 miles south of Rabat, Morocco. It is stated that the Moroccan Service of Mines considers the deposits to be of great value.

United States.—The Black Range tin deposits of New Mexico have already been described in this BULLETIN (1921, **19**, 428).

According to J. M. Hill (*Bull. No.* 725G, *U.S. Geol. Survey*, 1921), the veinlets of cassiterite and specular hæmatite at Taylor Creek, on the west side of the Black Range, occur in soft altered rhyolite. In general there are two fairly distinct sets of fractures—one striking N. to

N. 20° E., and the other N. 60° E. to E. The rhyolite adjoining the fractures has been kaolinised; silicification is conspicuously absent, being in this respect unlike the veins carrying wood-tin in rhyolite near Battle Mountain, Nevada (Adolph Knopf, *Bull. No.* 640G, *U.S. Geol. Survey*, 1916). The cassiterite in general is deposited as dark-brown or black, rather dense, botryoidal masses, and, in a few places, as brilliant red flaky crystals. The hæmatite is usually crystallised in brilliant black plates, and, in a few places, has been deposited in red botryoidal masses.

According to Marshall Haney (*Canadian Min. Journ.*, Oct. 1, 1920, p. 801), tin ore has been known to exist on Irish Creek, Rockbridge Co., Virginia, since 1840. At the time of its discovery some prospecting pits were sunk and samples were found to carry both tin and silver. In 1883 a company was organised to work the tin deposits of the area, which is about 4 miles long and 3 miles wide, but little appears to have been done, and production has been insignificant. Nevertheless, Haney considers that the area offers good prospects. The ore is found in well-defined quartz veins cutting in all directions a granitic rock much decomposed for 50 ft. in depth. The veins vary from 1 to 8 ft. in width and the tin content from 1 to 13 per cent.

Bolivia.—In *U.S. Comm. Rept., No.* 219, 1920, p. 1299, it is stated that the Yungas region of Bolivia, in the departments of La Paz and Cochabamba, is not of importance as a mining district owing to its isolation.

In the Pichu district near Yanacachi the mineral deposits are largely tin ores, whilst those of the Chojlla district are tin and tungsten ores. The most important mining enterprise in that region is that of an American company, which produces tin, lead and wolfram, and controls an area of 8,600 acres. The production of tin barilla, with about 50 per cent. of tin, averages 60 tons per month.

According to the *Bd. of Tr. Journ.* (June 19, 1919, p. 774), a new tin-producing area has been opened at Berenguela in the Cochabamba department of the province of Argue. During 1918, 600 tons of tin concentrate from this area were exported, and it was stated that many other tin deposits in the same district were awaiting exploitation.

Tungsten Ores

Owing to cessation of demand and to a large accumulation of stocks of concentrate, tungsten metal, ferro-tungsten and high-speed steel, the tungsten industry was

almost suspended after the war. Production, however, did not immediately cease, especially in China, Indo-China, Japan, Burma, Bolivia, and the Federated Malay States. According to the estimate of *Min. Ind.*, 1920, the world's production of 60 per cent. concentrate for the years 1916–20 was: 21,000; 25,500; 32,000; 20,000; and 11,000 tons respectively. Of the 1920 output China supplied 4,550 tons and Burma 2,500 tons. The next largest producers, with their tonnages, were: Australia, 422; Federated Malay States, 400; Bolivia, 300. The Unfederated Malay States produced 200 and England 140 tons. In the United States production was reduced to 196 tons in 1920, on account of the low prices of ores imported from the East. During the war the price at one time reached \$93 a unit; in February 1922 Chinese ore was quoted at \$2 in New York. In the United Kingdom the controlled price of 60 shillings a unit was maintained till March 1920, when the market again became free.

As a result of special investigations many potential sources of ore were discovered during the war, but at present prices most of them cannot be exploited. China is credited with being able to supply the world's requirements for many years at prices below competition.

Uses of Tungsten.—In *Mining Journ.* (Sept. 3, 1921) a new use for tungsten in the form of its carbide is reported. Tungsten carbide can now be produced in a compact mass with a hardness of 9·8 as compared with 10 for the diamond, and it has been found to be an efficient substitute for bort, or black diamonds, used for drilling, glass cutting, dies for hard wire drawing and other industrial operations. One considerable advantage it possesses over the diamond for such purposes lies in the fact that it can be made to form a cutting tool of any desired shape or size. Practical drilling tests, with the carbide taking the place of bort as a rock-cutting agent, have shown it to possess marked superiority to the diamond in the speed of cutting through various kinds of hard rock.

India.—In the "Quinquennial Review of Mineral Production in India" (*Rec. Geol. Survey, India*, 1921, **52**), J. Coggin Brown states that no new deposits of tungsten ore have been discovered in India in recent years. Brief particulars are given of the Singhbhum and Rajputana deposits. The former occurs near Kalimate, and the ore consists of pockets of wolframite in quartzite at the junction with overlying micaceous schists. At the Degana mine in the Marwar district of Rajputana wolframite is

found in thin quartz veins in a granite country-rock. It is pointed out that the known resources of tungsten ores in Burma extend in a belt from Bymgyi from the southern Shan States to Maliwan in the extreme south of Mergui, a distance of approximately 750 miles. In most of the deposits the tungsten minerals are associated with cassiterite. The veins may occur in either granite or old sedimentary rocks, and are often observed passing from one to the other. Detrital or residual deposits of wolframite and cassiterite occur on hill slopes below the outcrops. Alluvial and ancient beach deposits may contain cassiterite but not wolframite, unless it is protected by a quartz matrix.

In *Econ. Geol.* (1920, **15**, 511), J. Morrow Campbell, in discussing the tungsten deposits of Tavoy, states that the ore-bearing veins, whether in granite or in sedimentary rocks, rarely exceed 5 ft. in width, and are generally less, but they are in some cases numerous.

In most of the wolframite mines in Tavoy the ore-bodies are small and it is exceptional to find them over 2,000 ft. in length. The average wolframite recovery from the whole of the ore mined in Tavoy does not exceed 1 per cent., and few mines can claim a recovery as high as 2 per cent. Wolframite and scheelite are always associated, but neither ferberite nor hübnerite has been proved to exist in Burma. The Tavoy veins contain no tourmaline and fluorspar, and topaz only sparingly. Other minerals sometimes, but not commonly, present are pyrite, molybdenite, native bismuth, chalcopyrite, magnetite, hæmatite, ilmenite, stibnite, pyrrhotite, blende, galena and siderite.

Nigeria.—In *Ann. Rept. Mines Dept., N. Nigeria*, 1919, a small production of wolfram in the form of tin-wolfram concentrate is reported in that year amounting to just over 29 tons of wolframite (65 per cent. WO_3), all of which came from the district of Luruie-n-Kano in Kano Province, Northern Provinces. Wolfram has also been discovered on the Bauchi Plateau, but no production appears to have yet taken place.

Canada.—In *Manitoba Bulletin* on "Mineral Prospects in South-Eastern Manitoba," 1920, J. S. de Lury refers to a number of small outcrops carrying scheelite in notable quantities in the Boundary district of Manitoba. One of the best outcrops was located in 1918 on the Empress claim. From this a shipment of cobbed material was sent to the Department of Mines, Ottawa, of total weight 7,921 lb., containing 1·65 per cent. of tungstic oxide.

The weight of concentrate produced with 95·9 per cent. recovery was 177 lb. This is not very encouraging, but further prospecting may yield better results.

Australia.—The Forth Valley deposits in the Mount Pelion mining district have been fully described by A. McIntosh Reid in *Bull. No.* 30, 1919, *Geol. Survey, Tasmania*. The ore-bodies enclosed in quartzites and quartz schists, which underlie all the formations of the district, are wolframite-bearing quartz veins cutting these formations. Associated metallic minerals are cassiterite, molybdenite, arsenopyrite, chalcopyrite and pyrite. The non-metallic minerals are fluorspar, topaz, tourmaline and gilbertite. Only wolframite and cassiterite are present in commercial quantity, the former greatly predominating with a content of about 4 per cent. of tungstic acid. An average sample gave 4·66 per cent. of tungstic acid and 0·30 per cent. of tin. Production has commenced, but no estimate of reserves is yet possible.

The tungsten-bearing area in the neighbourhood of Moina, Tasmania, has been referred to in the *Monograph* (p. 40). More detailed information on the geology of the area has been recently given by W. E. Hitchcock and J. R. Pound in the *Trans. Australian Inst. Min. Eng.* (abs. in *Min. and Sci. Press*, February 14, 1920, p. 229).

The geological associations of the deposits are described as sandstone, quartzite and limestone beds, forming a contact metamorphic zone around a mass of granite and granite porphyry. The lodes are a complex of veins which traverse the metamorphosed sedimentary rocks. The mineralisation consists of cassiterite, wolframite, scheelite, bismuthinite, bismutite and pyrite, and the gangue consists mainly of quartz, topaz, fluorspar and mica. At the principal mine are five nearly vertical lodes. Workings have reached 300 ft. in depth without change in the tin and tungsten contents, but with less bismuth than is found at higher levels.

Reference has been made in the *Monograph* (p. 41) to the occurrence of scheelite on King Island, Tasmania. Further particulars are given in a paper by Herbert Lavers (*Proc. Aust. Inst. Min. and Met.*, No. 43, 1921).

The sedimentary rocks, in which the scheelite occurs, are altered near an intrusive granite mass to spotted schists and very hard, black, flinty hornstone. The metallic minerals are scheelite, molybdenite, pyrite and bismuthinite. The gangue is essentially garnet (andradite), which is magnetic; other gangue minerals are quartz, epidote, calcite, monoclinic pyroxene and actino-

lite. The scheelite occurs in minute grains disseminated through the garnetiferous mass, as well as in crystals ¼ in. or more across, and in amorphous masses several inches wide. The grade of the ore varies from 0·7 to 1 per cent. of tungstic acid. The ore is coarsely crushed; such gangue minerals as quartz, aplite, etc., are removed by Wilfley tables, and the resulting garnet-scheelite concentrate is passed under a magnet, which removes the garnet, leaving a marketable product of high-grade scheelite.

For the six months ended March 31, 1920, 15,820 tons of ore averaging 0·67 per cent. of tungstic acid produced 121 tons 7 cwt. of concentrate, averaging 69·6 per cent. of tungstic acid, representing a recovery of 79·5 per cent.

Italy.—The *Giornale di Chimica Industriale ed Applicata* (Aug. 1920, p. 465) reported that during the war Italy was under the necessity of importing considerable quantities of tungsten for making special steels. This has since caused attention to be given to the Italian resources of tungsten minerals. In the newly acquired territory of the Venezia Tridentia, formerly part of Austria, tungsten ore associated with copper ore has been found in a deposit at Bedovina, in Val di Fiemme, near Predazzo. The ore in sight is estimated at 180,000 tons containing 2,160 tons of copper and 450 tons of tungstic oxide.

China.—In the *Monograph* a brief reference is made to the tungsten ore deposits of China. This information has been amplified by a note entitled "Tungsten in China" in this BULLETIN (1921, **19**, 70), in which the economic features of the Chinese tungsten industry are discussed, and further information is given regarding the deposits. Their geological conditions are generally described, and there are special references to the Kowloon deposits near Hong Kong; the Pingshan and San To Chuk stockwork deposits of Kwantung; the quartz veins of the Kuku mines, east of Shiuchow, Kwantung; the Tin Nam deposits in the southern part of Kiangsi; the Yukongshien deposits of Hunan; and some recently discovered deposits on the mainland of the British Colony of Hong Kong known as "New Territory."

Indo-China.—According to *Bull. de L'Agence Gen. des Colonies* (Apr. 1920, p. 459), the tin-tungsten mines of Tonkin produced, in 1918, 604 metric tons of concentrate, of which 218 tons contained 70 per cent. of wolframite and 257 tons were of mixed tin and tungsten concentrate.

Russia in Asia.—According to *U.S. Comm. Rept.*, No. 220, 1920, wolframite was discovered in Asiatic Russia in 1911–12 in the Neitchinsk region, Transbaikal Province. There are at least four deposits: (1) on the Bukuka Mountain, 66 miles from the Bordza Station on the Transbaikal Railway; (2) four miles from the Khara-Nor Station on the same railway; (3) near the village of Olanda, 40 miles east of Bordza Station; and (4) on the Sherlov Mountain, 16 miles from the Bordza Station. The Bukuka Mountain deposit, although situated in a virgin forest far from a railroad, produced small quantities of tungsten ore prior to the war. The mine near Khara-Nor Station contains both wolframite and scheelite, but has not been extensively worked. The deposits near the village of Olanda are on peasant lands and appear to be numerous but small, and are scattered over a comparatively large area. The Sherlov Mountain is well known. Its mines have produced semi-precious stones—aquamarines and topazes—for many years. Tungsten minerals are also present, but so far have not been mined.

Tungsten has been reported in the Kolyvan mines and at Zineinogorsk, Altai; in the Berezov region of the Ekaterinburg mining district; in the south of Batum, Caucasus; and near the source of Solgutidon Creek, which is a tributary to the Urukh River, Caucasus.

Siam.—According to *U.S. Comm. Rept.*, No. 209, 1919, the production of tungsten ores in Siam for the fiscal year ending Mar. 31, 1917, was 584 tons, and for the succeeding year about 800 tons. Local mining engineers assert that the potential production of tungsten of Siam is practically unlimited, and that the ores are widely diffused throughout Siamese Malaya and Northern Siam, although so far the richest deposits have been found in the Nakawm Sritamarat district. Mining has hitherto been left mainly to Chinese, who have limited their operations to surface work. The production of tungsten practically ceased with the beginning of 1920, but it is said that Bangkok dealers are prepared to guarantee almost unlimited supplies for future shipments.

United States.—The contact-metamorphic tungsten deposits of the United States are described by Frank L. Hess and Esper S. Larsen (*Bull. No.* 725D, *U.S. Geol. Survey*, 1921). The tungsten mineral of such contact-metamorphic deposits is invariably scheelite (calcium tungstate), and it is noteworthy that, although a number of minerals are present in some of the deposits, no boron mineral, such as tourmaline, has been detected in any of

them, and, except in one deposit, little original hæmatite or magnetite. In the Western United States the chief producing deposits of this type are on the eastern slope of the Sierra Nevada, near Bishop, California; in the Eugene Mountains, near Mill City, Nevada; and in several ranges near Lovelocks, Nevada.

The deposits at Bishop, Inyo County, California, are referred to in the *Monograph* (p. 63), and were described by Adolph Knopf (*Bull. No.* 640L, *U.S. Geol. Survey*, 1917). According to Hess and Larsen, the greater part of the ore is the metamorphosed limestone or tactite, as it is termed by Hess. Some of the larger bodies are completely changed to lime silicate rock, but some of the smaller bodies have only narrow, discontinuous borders of such rock. The prevalent mineral is a dark brown garnet, with more or less quartz, some epidote, and a little scheelite, apatite and titanite. It is stated that two companies have milled 137,000 tons of ore from the district which averaged about 0·5 per cent. tungstic acid. At Pine Creek, west of Bishop, there is a body of tactite, which follows the contact between granodiorite and marble for nearly a mile and is locally 70 ft. across. The surface features indicate a large tonnage of tactite, or roughly 500,000 tons for each 100 ft. of depth. A large body at the south end of the deposit is said to average a little over 1 per cent. of tungstic acid.

At Mill City, Nevada, the contact-metamorphic deposits cover an area of about one square mile. The ore deposits are portions of limestone beds that have been replaced, near the granodiorite contact, by an aggregate of pale brown garnet and greenish epidote in variable proportions, with considerable quartz and calcite, and some sulphides, zeolites and scheelite. The ore mined averaged 2 per cent. of tungstic acid.

The deposits near Toy, and the Ragged Top mines, in the Lovelocks district, Nevada, are referred to in the *Monograph* (p. 68). The ore of the St. Anthony mines, near Toy, is said to have yielded about 1 per cent. of tungstic acid. Operations ceased early in 1917, but afterwards were resumed, and ore developed at the bottom of the shaft is said to have carried 2 per cent. of tungstic acid. Several thousand tons of ore were taken out of an open cut in the Ragged Top mines, which was on one of the largest masses of limestone. The most prominent minerals in the tactite are brownish garnet, calcite, quartz and scheelite. The rock also contains a little epidote, chloropal, halloysite, pyrite and chalcopyrite. A lens, 12–14 ft. long, 12–14 in. thick and 8 ft. deep, is said to

have carried 49 per cent. of tungstic acid, but 3,600 tons of ore shipped for milling before a mill was erected on the mine averaged 1·25 per cent. of tungstic acid. Operations ceased here in 1917.

H. G. Ferguson briefly describes the tungsten deposits of the Round Mountain district, Nevada (*Bull. No.* 725I, *U.S. Geol. Survey*, 1921, p. 388). Small veins in microcline-granite carry hübnerite, and there was a small production during the war, but development ceased in 1919. The quartz veins which carry the hübnerite range from thin stringers to masses 1½ ft. in width, strike between N. and N. 20° E. and dip about E. 45°. Muscovite is usually confined to a narrow band close to the walls. Fluorspar, in complex delicate pink crystals, is present in nearly all the veins. Hübnerite is the only metallic mineral present, except in a few veins close to the slate contact, where a little tetrahedrite also occurs.

NOTICES OF RECENT LITERATURE

The Red Book of the West Indies. Compiled and edited by Allister Macmillan, F.R.G.S. Pp. 424, 4to, 11 × 8¾. (London: W. H. and L. Collingridge, 148 and 149, Aldersgate Street, E.C., 1922.) Price 84*s.*

Although a number of useful books and articles on the West Indies has appeared during recent years there is ample room for a publication of this kind. The book is an enlargement of a similar volume prepared by the writer in 1909 and will be found to be a valuable source of commercial and industrial information regarding the territories described. It deals with the British West Indies (including the Islands and British Guiana, but not British Honduras), Cuba, Porto Rico, the French and Dutch West Indies, and the Virgin Islands of the United States, formerly the Danish West Indies ceded to America in 1917. The volume contains much interesting historical and descriptive matter for which the editor is indebted to several well-known authorities on these subjects, and the numerous illustrations (including reproductions of old prints of much interest) add greatly to the attractiveness of the work.

A uniform plan has been adopted wherever possible in dealing with the various countries. An historical account (which in the case of most of the West Indies implies exciting reading) is accompanied by a description

of the inhabitants and scenery of the country. The main purpose of the book, however, is commercial, and full attention is therefore given to an account of the resources and industries of the countries, actual or potential, while a section is devoted to a detailed description of the chief local commercial undertakings, which should be useful for reference purposes. The book is up-to-date, as for example in its reference to the establishment of the West Indian Agricultural College at St. Augustine, Port of Spain.

In recent years the British West Indies has enjoyed considerable prosperity following upon a variety of causes, and although the high-water mark (as regards values, at any rate) reached during the war has been followed, as elsewhere, by a reaction, there is no reason to doubt that a satisfactory recovery will take place before long. A practical handbook of the character of "The Red Book" will certainly prove of use to merchants and others in this country and other parts of the Empire seeking to help in, and take advantage of, that ultimate recovery.

THE EAST AFRICAN RED BOOK, 1922–3. Handbook and Directory for Kenya Colony and Protectorate, Uganda Protectorate, Tanganyika Territory and Zanzibar Sultanate. Compiled by the East African Standard, Ltd. Pp. 617, 9½ × 6½. (Nairobi and Mombasa : East African Standard, Ltd., 1922.)

This new edition of "The Red Book" differs from earlier issues in dealing not only with Kenya and Uganda but also with Tanganyika and Zanzibar.

The book is prefaced by an interesting history (covering 54 pages) of East Africa, together with a list of the more important works of reference on the countries concerned.

It has not been possible to compile directories of the whole of the residents in East Africa, but an endeavour has been made to include the heads of government departments, leading members of the professions, and all those whose work brings them prominently before the public.

In addition to the directories, the work contains a brief account of the topography and meteorology of each country, together with information regarding communications, population, administration, agriculture, lands, currency, postal arrangements, finances and customs, ordinances, imports and exports, and many other matters of interest both to those resident in East Africa and to those overseas who require particulars regarding this vast territory.

THE ECONOMIC RESOURCES OF ITALY. 2 vols., 8vo, $10 \times 7\frac{3}{4}$. (Milan: Credito Italiano, 1920.)

The first volume of this admirable publication contains 238 pages of letterpress in English, devoted to the "development of the economic resources of Italy during the last twenty-five years and their present condition," followed by a series of excellent photographs of the chief towns of Italy. The second volume consists entirely of photographs illustrating the agriculture, manufacture, transport and other industries of Italy and her African possessions.

The volumes are printed and bound in a most artistic and attractive style. The entire compilation furnishes a valuable conspectus of the recent progress and present position of Italy from an economic and industrial standpoint, and the Credito Italiano are to be complimented on their enterprise in preparing and issuing the volumes.

HANDBOOK OF COMMERCIAL GEOGRAPHY. By Geo. C. Chisholm, M.A., B.Sc. (Edin.). Ninth Edition. Pp. xvi + 824, 8vo, $8\frac{3}{4} \times 6$. (London: Longmans, Green & Co., 1922.) Price 25s.

The publication of this new edition of Mr. Chisholm's well-known work was delayed for some years on account of the war, and even now, as stated in the Preface, it is "issued to an unsettled world." For this reason a large number of the statistics which the book contains have not been carried beyond 1913–14, but the revision of the work as a whole is nevertheless fully justified, as the eighth edition appeared as long ago as 1911 and has had to be reprinted several times.

In the present issue many useful alterations and additions have been made, particularly in sections where modification was necessary on account of conditions brought about by the war. Account has been taken, for example, of the political changes in Eastern Europe and elsewhere, in so far as they may be regarded as permanent. As a result of these and other improvements some 150 pages have been added, enhancing the already well-established value of this comprehensive volume, the scope and utility of which could only be adequately indicated by extensive quotation.

The subject-matter of the work in some places may be said to go beyond even the wide scope allowed for by the title, as for example in the section dealing with Currencies and Rates of Exchange (pages 107–111), and the information furnished regarding the invention of machinery

for various purposes and the methods of preparation of economic products. The book is instructive in a high degree, and contains a mass of information of the utmost value to teachers of geography, students of economics, and all interested in commerce from an educational standpoint.

Among the special features which contribute to the usefulness and interest of the volume may be mentioned the admirable system of cross-references employed; the series of excellent maps illustrating commercial trade routes and other geographical features; the insertion (in the form of foot-notes) of the populations of the principal towns in various countries; and the Appendix, consisting mainly of statistical tables of imports and exports of the principal countries and followed by an instructive list of alternative geographical names in various languages.

It is, however, much to be regretted that a further edition of this valuable work should have been brought out without more complete and careful revision, especially of the sections dealing with economic products, which contain numerous inaccuracies and carelessly worded statements liable to mislead the reader. A few examples of these avoidable defects are given below.

P. 21. Paragraph 48 commences, "My attention has only recently been called to the fact that . . ." The verbatim repetition of this phrase, which appeared eleven years ago in the eighth edition (p. lxiv), is obviously unsuitable.

P. 197. Sisal hemp is here erroneously referred to as "a rival to jute."

Pp. 200 *et seq.* The section on Rubber, like a number of others, should have been drastically revised instead of being reproduced practically verbatim from the earlier edition. It is not now true to say regarding Hevea rubber that "by far the largest supply is obtained from trees growing in the Amazon Valley"; and the assertion that "a composite shrub of the temperate zone has added considerably to the rubber supply of the world" gives a totally unwarranted prominence to guayule rubber.

P. 209. In paragraph 462 no distinction is drawn between palm oil and palm kernel oil; a statement moreover appears from which the reader is led to imagine that "Babassu nuts" are the kernels of the ordinary oil palm (*Elæis guineensis*) instead of being derived, as they are, from a totally distinct tree, a species of *Attalea*.

P. 263. There is a reference here to the monazite obtained from Brazil, the United States and Ceylon, but

the very important and commercially valuable deposits of Travancore are not mentioned.

P. 297. No proper distinction is drawn between the Yorkshire Ouse and the Great Ouse, and even the foot-note does not make matters clear.

Pp. 584–5. "The British settlements on the Gambia" is a somewhat strange description of the well-known Colony of Gambia. The important and old-established Colony of the Gold Coast is dismissed in a few sentences, and the French territories of the Ivory Coast and Dahomey receive even scantier notice. A statement is made that the administrative centre of Nigeria has been transferred to a place inland, at an altitude of over 2,000 ft., whereas in fact the Government headquarters are still at Lagos.

P. 587. The statement in paragraph 1203 that deposits of tin ore "have been discovered" in the Northern Provinces reads rather strangely in view of the fact that the ore has been worked for a number of years and a quantity of nearly 8,000 tons was exported in 1920.

P. 589. A foot-note here states that Nyasaland is "reckoned" as part of Rhodesia, but is under the administration of a Commissioner. Both these statements are inaccurate. Nyasaland is in no sense part of Rhodesia, and has for many years been a British Protectorate administered by a Governor.

Pp. 590–91. Serious misstatements are here made regarding the political divisions of the British Possessions in East Africa. The reader would gather from the somewhat confused description that Kenya Colony was under a number of different administrations, and that the greater part of it forms the "East Africa Protectorate," whilst in fact the latter Protectorate has ceased to exist, and Kenya Colony is an administrative unit. The statement made regarding Uganda implies that this Protectorate is a part of Kenya Colony, whereas the two countries are entirely distinct.

The inaccuracies criticised above and others of a similar kind could easily have been avoided by the submission of the various sections to experts conversant with the subjects dealt with. Much improvement could also be effected in the wording, which is in some places clumsy and in others obscure. It is to be hoped that before the tenth edition is issued these matters will be fully attended to and the value of the work correspondingly increased.

A Manual of Indian Timbers. By J. S. Gamble, M.A., C.I.E., F.R.S., F.L.S. Reprint of Second Edition,

with some additions and corrections. Pp. xxvi + 868, $8\frac{3}{4} \times 5\frac{3}{4}$. (London: Sampson Low, Marston & Co., Ltd., 1922.) Price 63*s*.

A new issue of this invaluable book, for long out of print, has been a most important desideratum. The recent growth of interest in Indian timbers for decorative and other purposes in this country, and the greatly increased attention being given to the use of local woods in India itself, have accentuated the need for a readily accessible handbook on Indian woods. The appearance of the present reprint, therefore, is most welcome. As the "Manual" is now available to a new public it will not be out of place to refer to the general scheme of the work. The book is an authoritative account of the growth, distribution and uses of the trees and woody shrubs of India, with descriptions of their timbers and the purposes for which they are employed. The species are dealt with in botanical sequence. The nomenclature (botanical and native) is followed by a statement of the principal features of the wood as regards physical characters and gross structure, and full information is given of its uses and of the records of strength tests so far as they were available at the time of the publication of the second edition (1902). There is also in each case an account of the distribution and occurrence of the tree. The book includes a series of low-power photomicrographs of the most important woods, as well as a number of photographs of forest trees and forest scenery, while its practical utility is enhanced by the complete indexes, of which one is a valuable compilation of native names.

The additions appearing in the reprint comprise two appendixes, the first containing a description of certain wood specimens received by the author since the publication of the second edition; the second is a description of a collection of specimens of Assam woods received from Rai Bahadur Upendranath Kanjilal, F.L.S., in 1921.

The Forests of India. By E. P. Stebbing, M.A. (Professor of Forestry, University of Edinburgh). Vol. I. Pp. xv + 548, 8vo, $8\frac{3}{4} \times 5\frac{3}{4}$. (London: John Lane, the Bodley Head, Ltd., 1922.) Price 42*s*.

In this work (the first of two volumes) the writer's aim has been to give a detailed narrative of the progress of Forestry in the different Provinces of India and "the steps by which that progress has been achieved." The book is written more particularly for Indian Forest Officers and members of other Services directly or indirectly

concerned with the forests of the country, but it is also eminently readable as a popular treatise, containing a large amount of historical, geographical and other information likely to be of interest to a wide circle of the general public.

The volume is divided into four parts, dealing respectively with the early history of the forests of India, their position and treatment from 1796 to 1850, the "beginnings of forest conservancy" in 1850–57, and the "initiation of forest conservancy" in 1858–64. Copious extracts are given from reports on the Indian forests illustrating the gradual growth of a policy of forest administration, in contrast to the haphazard conditions and official indifference formerly prevailing even under British rule.

The utility of forests in general, in the matter of rainfall, soil conservation and so on, is well described, and in connection with this and other technical and scientific matters the volume affords much useful information, quite apart from its main purpose, which as already indicated is essentially historical. The book contains a rainfall map of India, and a number of illustrations, which though not essential to the general plan of the work form a useful feature and in some cases present views of considerable scenic beauty as well as of topical interest.

It is not possible in a short review to give an adequate idea of the wealth of detail contained in Professor Stebbing's book and the clear view he presents of the forestry problems of India. It may, however, be useful to indicate the far-reaching utility of the work and its interest to other parts of the Empire, by quoting the following paragraph from the author's Introduction:

"Whilst engaged upon the History, I have become impressed with the fact that this work will prove not only of value to India, but to the younger forestry services under the Colonial Office. Many of these are in the position with which India was faced half a century ago. Shifting cultivation is practised over extensive areas; the firing of the forests and unchecked grazing are still rife; methods of exploiting the forests by timber merchants or the local population are still far from being organised on up-to-date lines, and so forth. A study of how these practices were gradually checked and order brought into the forestry estate in the different Provinces throughout India (and the steps taken were by no means the same in each) should prove of considerable value to the Colonial Forest Services."

Professor Stebbing's wide experience as a Forest Officer in India and his official position at the University of Edinburgh should combine to render the present work

authoritative in a high degree. It is to be hoped that the second volume, in which the author proposes "to trace the development of the Forest Department" in India from 1864 up to the present time, will not be long in making its appearance

THE FUNDAMENTALS OF FRUIT PRODUCTION. By Victor Ray Gardner, Frederick Charles Bradford, and Henry Daggett Hooker (jnr.), of the Department of Horticulture of the University of Missouri. Pp. xvi + 686, 8vo, 9½ × 6. (London and New York: McGraw-Hill Book Co., Inc., 1922.) Price 22s. 6d.

This comprehensive work is primarily intended for college students in the United States of America, but, as the fundamental factors involved in fruit production are of universal application, it has a much wider appeal. It is not a textbook of fruit culture, but it endeavours to explain the principles that underlie the best cultural methods, and to this end the subjects of plant physiology, plant chemistry, soil science, and physics have been introduced. Once these principles are thoroughly understood by the cultivator the adaptation of practical methods to local conditions should present little difficulty.

Although there is little original matter in the volume, the work itself is unique in that it presents in a connected form a vast amount of information that has not hitherto been available except in a very extensive and scattered literature.

The work is divided into seven sections which deal respectively with the following subjects: (1) water relations, (2) nutrition, (3) temperature relations of fruit plants, (4) pruning, (5) fruit setting, (6) propagation, and (7) geographical influences in fruit production. Each section is divided into several chapters, and each chapter is summarised; while appended to each section is an exhaustive bibliography divided into "suggested collateral readings" and "literature cited." The literature cited for the most part consists of reports issued by experimental stations in the United States, and as indicating the amount of experimental work that has been done relating to fruit culture it is worth while stating the number of references to reports and other publications quoted in each of the seven sections. They are respectively as follows: 139, 204, 219, 52, 144, 156, 67—a total of 981. It will thus be seen that the student is saved a considerable amount of time and labour in having the substance of such a number of publications given in a connected form in one volume. As a supplement to manuals dealing with the practical

side of fruit cultivation this volume should prove of much value to the practical man as well as to the student.

TEXTILES. By A. F. Barker, M.Sc. With Chapters on the Mercerised and Artificial Fibres, and the Dyeing of Textile Materials, by W. M. Gardner, M.Sc., F.I.C.; Silk Throwing and Spinning, by R. Snow; the Cotton Industry, by W. H. Cook, M.I.Mech.E.; the Linen Industry, by F. Bradbury. Revised Edition. Pp. xii + 386, 8vo, 9 × 5¾. (London, Bombay and Sydney: Constable & Co., Ltd., 1922.) Price 15*s*.

In this book an attempt has been made to give an account of the whole range of textile industries, including the production of the various fibres, their preparation for the processes of manufacture, the various operations of spinning, weaving, designing, colouring and finishing, and the conditions and organisation of the textile trades. It is obvious that so vast a field cannot be adequately covered within the limits of a small textbook, and the result is that, whilst certain sections are dealt with in some detail, other sections are treated in a meagre or incomplete manner.

It is unfortunate that in this "revised edition" the list of vegetable hairs and fibres (on pages 50–52) should contain a great many misspellings, particularly in the scientific names, of which approximately one-half are incorrect. Again, in a table headed "Working Lengths and Average Diameters [of] the Principle (*sic*) Vegetable Fibres," the working lengths given are those of the strands of fibre in ordinary commercial consignments, whilst the diameters are not those of the strands, as would be expected, but those of the ultimate fibres. This fact, however, is not mentioned and the table is therefore liable to be very misleading to the student. In the same table there appears a curious confusion between the banana and pineapple, thus: "Ananassa or Banana Fibre. *Ananas sativa* (Pineapple Fibre)."

Apart from these blemishes, the work as a whole is well written, contains many excellent illustrations, and forms a useful general introduction to the subject of the textile industries.

LINEN. By Alfred S. Moore, M.Text.Inst. Pp. viii + 205, 8vo, 8½ × 5¾. (London, Bombay and Sydney: Constable & Co., Ltd., 1922.) Price 10*s*. 6*d*.

This book forms Volume III of the series of "Staple Trades and Industries" which is being produced under

the general editorship of Gordon D. Knox. The first two volumes of the series, on "Wool" and "Cotton," have already been noticed in this BULLETIN (1918, **16**, 583, 584).

The work has been written for the general reader, rather than for the expert, and the subject has therefore been treated in a somewhat popular manner. It is intended "particularly for business men who may suddenly find themselves obliged to be interested in linen, or in its raw material, flax."

The author gives an historical sketch of the linen industry of the world from the earliest times, special chapters being devoted to Great Britain and Ireland. The present position of the trade and the world's flax supply are considered, and reference is made to the possibilities of flax production in the British Empire, including India, Canada, Australia and Kenya Colony.

The cultivation and harvesting of flax are dealt with and the methods of retting, breaking and scutching are described. An account is given of the processes to which flax is subjected in preparation for spinning, and the methods employed in spinning and weaving are discussed. Other chapters deal with designing, the manufacture of damasks, bleaching and finishing, the classification of linen goods, the linen markets and organisation of the trade and the future of the linen industry.

The book is written in an interesting manner and contains some excellent illustrations.

THE LEATHER TRADES' YEAR BOOK, 1922. Edited by Dr. J. Gordon Parker. Pp. lxiii + 192, 8vo, $9\frac{1}{2} \times 6\frac{1}{2}$. Published on behalf of the Joint Standing Committee of the United Tanners' Federation and the Federation of Curriers, Light Leather Tanners and Dressers, Inc. Price 6s.

This publication, formerly known as *The Tanners' Year Book*, has now reached its fourteenth edition, and the present issue well maintains the standard of interest set by its predecessors. Information is supplied concerning the various educational, research and trade organisations in the United Kingdom associated with the leather industry, together with lists of members. The greater portion of the book, however, consists of a collection of about twenty original articles dealing with a variety of subjects relating to the leather industry, among which the following may be mentioned: Chrome Upper Leather, by D. Woodroffe, M.Sc.; Some Notes on American Tannery Conditions, by Prof. D. McCandlish; The Chemical Control

of Limeyard and Tanning Liquors, by W. R. Atkin, M.Sc.; Progress in Upper Leather Manufacture, by H. G. Crockett; Synthetic Tannins, by G. E. Knowles, F.I.C.; The American Extract Situation, by R. W. Griffith, President, National Association of Tanning Extract Manufacturers [of the United States]; Recent Progress in Leather Trades' Chemistry, by S. Hirst.

The work concludes with a series of statistical tables giving quantities and values of imports and exports of hides, skins, tanning materials, etc., for the last three years.

A TEXTBOOK OF MINERALOGY. By E. S. Dana. Third Edition, by W. E. Ford. Pp. ix + 720, 8vo, 9 × 6. (New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd., 1922.) Price 25s.

The appearance of a new and revised edition of this standard textbook, after more than twenty years, is very welcome. The form of the previous edition has been retained, but numerous additions have been made, in spite of which the bulk of the volume has been kept within reasonable limits by printing much of the descriptive matter in small type. Very little change has been made in the order of classification of the mineral species pending the publication of a new edition of Dana's *System of Mineralogy*, to which the present volume is so closely related. The chief alterations are the introduction of descriptions of the methods used in making stereographic and gnomonic crystal projections, the simplification of exposition in the chapter on optical properties, and the added descriptions of minerals discovered since the publication of the second edition of the work. A very useful appendix has been compiled giving lists of minerals grouped according to the important basic elements they contain.

The present edition is a masterly presentation of the whole science of mineralogy and will enable the work to retain its pre-eminent position.

AN INTRODUCTION TO THE CHEMISTRY OF RADIO-ACTIVE SUBSTANCES. By A. S. Russell, M.A., D.Sc. Pp. xi + 173, 8vo, $7\frac{3}{4} \times 5\frac{1}{4}$. (London: John Murray, 1922.) Price 6s.

This little volume contains a useful and concise summary of the more important facts relating to the chemistry of radio-active substances.

The author, whose work in this branch of chemistry

is well known, does not profess to deal with the subject in an exhaustive manner, but rather aims at affording an up-to-date summary suitable for the use of students, and it can be said that he has adequately attained his object.

A brief account of the sources of the radio-active elements is followed by an historical summary of radio-activity and the disintegration theory. This is succeeded by a consideration of the disintegration products of uranium, actinium and thorium. Other useful and interesting sections deal with isotopes, the analytical chemistry of uranium and thorium, and the separation of individual radio-elements. The concluding chapter discusses the use of radio-active isotopes of the common elements as indicators of the behaviour of the latter at small concentrations.

Zirconium and its Compounds. By Francis P. Venable. Pp. 173, 8vo, 9 × 6. (New York: The Chemical Catalog Co., Inc., 1922.) Price $2·50.

This is one of a series of monographs on chemical subjects, issued under the auspices of the American Chemical Society. It gives, in this comparatively small volume, a most useful and up-to-date summary of the knowledge available concerning the properties and preparation of zirconium and its compounds. The concluding chapters deal with the analytical methods for the estimation of zirconium and its technical applications. Owing to the large volume of original literature from which the author has drawn his material, the subject-matter has had to be very severely condensed, but this is to some extent compensated by an excellent bibliography containing over 800 entries.

The book should prove useful to all interested in zirconium and its compounds, the literature of which was previously very scattered.

Metallography. By Cecil H. Desch, D.Sc. (Lond.), Ph.D. (Würzb.), Professor of Metallurgy in the University of Sheffield. Third Edition. Pp. 440, 8vo, $7\frac{1}{2} \times 5\frac{1}{2}$. (London: Longmans, Green & Co., 1922.) Price 16s.

The second edition of this book appeared in 1913, and a new impression was issued in 1918. The present edition contains only a few more pages than the 1913 edition, but it has been thoroughly revised and brought up-to-date.

Part of the chapter on solid solutions has been rewritten and expanded, and fig. 30 relating to alloys of magnesium

and cadmium has been substituted for the one on sodium and potassium in the second edition. In the section on the preparation of micro-sections, additional reagents for etching alloys are given, and micro-etching and the new method of determining the distribution of impurities in solid solution, and especially of phosphorus and oxygen in steel, are described. In an important chapter on the physical properties of alloys, reference is made to the remarkable experiments of Kammerlingh Onnes, showing that at the temperature of liquid helium (2° above absolute zero) metals become "super-conductors," that is, their electrical resistance vanishes, and a current once set up in a closed conductor continues to pass indefinitely.

There is much new matter on corrosion and a large part of the section on the metallography of iron and steel has been rewritten. An account is given of the new light thrown on the subject of the three allotropic modifications of iron by the study of the space lattices of the metal by the X-ray method. Additional matter on the technical varieties of steel and cast-iron has been introduced, and the section on the influence of other elements on the iron-carbon system has been enlarged. The appendix, containing tables of the binary and ternary systems of which equilibrium diagrams have been published, now includes all the latest data.

Great progress has been made in the science of metallography in recent years, and the amount of literature available has consequently grown to large dimensions, yet the author, with his wide comprehension of the subject, has managed to compress with great clearness into a comparatively small textbook an immense amount of information, there being references to the publications of over five hundred workers in metallography. The work will be of great value to all interested in this branch of physical chemistry.

The Analysis of Non-ferrous Alloys. By Fred Ibbotson and Leslie Aitchison. Second Edition. Pp. x + 246, 8vo, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Longmans, Green & Co., 1922.) Price 12*s.* 6*d.* net.

The first edition of this useful practical textbook was published in 1914, and the experience obtained during the war, as regards the analytical control of metallurgical operations and the analysis of new non-ferrous alloys, has rendered some additions to the book desirable.

The present edition follows the same lines as the previous one, but contains about 50 more pages. The section dealing with the analysis of aluminium and its

light alloys has been considerably enlarged and particular attention has been given to methods for the separation of aluminium from zinc. Other new matter deals with the analysis of nickel alloys containing copper, chromium and iron. These additions greatly enhance the value of the book.

THE METALLURGY OF ZINC AND CADMIUM. By H. O. Hofman. Pp. xii + 341, 8vo, 9 × 6. (London: McGraw-Hill Book Co., Ltd., 1922.) Price 20s.

The present volume is a welcome addition to those already produced in Professor Hofman's series on metallurgy. The opening chapters deal with the physical and chemical properties of zinc and its industrial uses in much more detail than is customary in the majority of metallurgical textbooks. A brief account of the common ores of zinc is followed by useful detailed descriptions of the processes and plant used in zinc smelting and refining, the subject-matter being illustrated by numerous diagrams. To those engaged in research on the metallurgy of zinc the account of processes which have been tried but which have so far not proved a commercial success will doubtless prove of interest. Electrolytic processes for the recovery of zinc from its ores are well described, and the hydrometallurgy of zinc is considered with special reference to current practice at Great Falls in Montana and elsewhere. The section on zinc closes with a useful account of the manufacture of zinc oxide.

In the concluding 26 pages are described the occurrence, properties, treatment and uses of cadmium and its compounds.

The usefulness of this volume, which is quite up-to-date and well written, is enhanced by numerous references to original publications.

FUEL AND REFRACTORY MATERIALS. By A. Humboldt Sexton, F.I.C., F.C.S. New Edition. Completely revised and enlarged by W. B. Davidson, D.Sc., Ph.D., F.I.C. Pp. 382, 8vo, 8¾ × 5⅞. (London: Blackie & Son, Ltd., 1921.) Price 12s. 6d. net.

This is a new and enlarged edition of Prof. Sexton's well-known textbook. The chapters dealing with by-products, liquid fuel, calorimetry, and refractory materials contain most of the additional matter, whilst that on pyrometry has been shortened by the omission of descriptions of obsolete forms of pyrometers.

The book still suffers somewhat from a lack of proportion. Charcoal, for example, which is said to be " now

only used in a few minor metallurgical operations," is discussed at some length, while shale oil and powdered coal are each dismissed in less than a page. As in the previous edition, the important industry of lignite briquetting is not mentioned.

The chapters on "Testing Fuels" and "Refractory Materials," which are stated in the preface to have been brought up-to-date, are incomplete. In the former chapter methods of analysis are only very briefly described, and there is no reference to such matters as the determination of the coking properties or agglutinating power of coal. In the latter chapter no mention is made of work on modern refractories, such as sillimanite or zirconia.

The foregoing criticisms indicate that the revision of this book might well have been more drastic. The work will, however, doubtless still prove useful as a trustworthy guide to students requiring a broad outline of general principles.

Gasoline and Other Motor Fuels. By Carleton Ellis and Joseph V. Meigs. Pp. xix + 709, 8vo, 9½ × 6. (London: Constable & Co., Ltd., 1921.) Price 60s.

The constantly increasing demand for light oils suitable for use in internal combustion engines, and the large number of processes which have been used or suggested for obtaining such material, led the authors to produce the present volume, which consists of a summary of the information now available.

The opening chapters discuss the use of mixed fuels, methods of testing and refinery practice. About 500 pages of the book are occupied with descriptions of methods for cracking petroleum in order to obtain motor spirit, which are classified according to the type of process used. Unfortunately, however, in many cases the descriptions are only abridged patent specifications and the reader is given no indication as to whether the process has ever been tried on a commercial scale and, if so, with what results.

Other matters considered include methods for the condensation of liquid hydrocarbons from natural gas, the recovery and use of benzole, alcohol, and shale oil for motor fuel, and the pyrogenic decomposition of asphalt. The appendix includes a number of useful tables dealing with the output of crude and refined petroleum.

This volume should prove useful to all interested in the particular branches of motor fuel industry dealt with, and will be of special value for reference purposes by reason of the numerous original publications quoted in the text.

BOOKS RECEIVED

BRITISH NORTH BORNEO: AN ACCOUNT OF ITS HISTORY, RESOURCES AND NATIVE TRIBES. By Owen Rutter. Pp. xvi + 404, 8vo, 9 × 6. (London: Constable & Co., Limited, 1922.) Price 21*s*.

THE HANDBOOK OF PALESTINE. Edited by Harry Charles Luke, B.Litt., M.A., and Edward Keith-Roach. With an Introduction by the Right Hon. Sir Herbert Samuel, P.C., G.B.E., High Commissioner for Palestine. Pp. xii + 295, 8vo, 7½ × 5. (London: Macmillan & Co., Ltd., 1922.) Price 12*s*.

ENVIRONMENTAL INFLUENCES AFFECTING BLONDES IN RHODESIA AND THEIR BEARING ON THE FUTURE: A SURVEY OF THE SITUATION FROM THE MEDICAL AND SCIENTIFIC STANDPOINTS. By Dr. W. M. Hewetson, being a paper delivered before the Rhodesia Scientific Association at Salisbury, May 15th, 1922. Pp. 27, 8vo, 8½ × 5½. (Salisbury: The Rhodesia Independent Co., Ltd. London: Simpkin, Marshall, Hamilton, Kent & Co., Ltd.) Price 2*s*. 6*d*.

BUSINESS GEOGRAPHY. By Ellsworth Huntington and Frank E. Williams. Pp. x + 482, 8vo, 8¾ × 5¾. (New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd., 1922.) Price 13*s*. 6*d*.

INVESTIGATIONS ON OILPALMS. By Dr. A. A. L. Rutgers. Pp. vi + 125, 8vo, 10½ × 7¼. (Experiment Station A.V.R.O.S., Medan, Netherlands India, 1922.) Price 10*s*.

LABORATORY MANUAL OF FRUIT AND VEGETABLE PRODUCTS. By W. V. Cruess, B.S., and A. W. Christie, M.S. Pp. vii + 109, 8vo, 9 × 6. (New York and London: McGraw-Hill Book Co., Inc., 1922.) Price 7*s*. 6*d*.

AN INTRODUCTION TO THE CHEMISTRY OF PLANT PRODUCTS. VOL. II: METABOLIC PROCESSES. By Paul Haas, D.Sc., Ph.D., and T. G. Hill, A.R.C.S., F.L.S. Pp. viii + 140, 8vo, 9 × 6. (London: Longmans, Green & Co., 1922.) Price 7*s*. 6*d*.

Farm Buildings. By W. A. Foster, B.Sci. in Edu., B.Arch., and Deane G. Carter, B.S. in A.E. Pp. xv + 377, 8vo, $8\frac{1}{2} \times 5\frac{1}{2}$. (New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd., 1922.) Price 15s.

Marine Works: A Practical Treatise for Maritime Engineers, Landowners and Public Authorities. By Ernest Latham. Pp. xii + 174, 8vo, $8\frac{3}{4} \times 5\frac{3}{4}$. (London: Crosby Lockwood & Son, 1922.) Price 16s.

Mosquito Eradication. By W. E. Hardenburg. Pp. ix + 248, 8vo, 9×6. (London: The McGraw-Hill Publishing Co., Ltd., 1922.) Price 15s.

The Practical Applications of X-Rays. By G. W. C. Kaye, O.B.E., M.A., D.Sc., A.R.C.Sc., F.Inst.P. Pp. viii + 135, 8vo, $8\frac{3}{4} \times 5\frac{3}{4}$. (London: Chapman & Hall, Ltd., 1922.) Price 10s. 6*d*.

Princes of Wales. By F. Maynard Bridge. Pp. xi + 355, 8vo, $7\frac{3}{4} \times 5\frac{1}{4}$. (London: H. F. W. Deane & Sons, The Year Book Press, Ltd., 1922.) Price 8s. 6*d*.

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

The following summaries have been prepared from a selection of the Reports made by the Director of the Imperial Institute to the Dominion, Colonial and Indian Governments.

INVESTIGATIONS OF THE QUALITY OF PLANTATION RUBBER CONDUCTED UNDER THE CEYLON RUBBER RESEARCH SCHEME. IV.

In previous numbers of this Bulletin (1916, **14**, 495; 1918, **16**, 409; and 1920, **18**, 1) accounts have been given of the results of vulcanisation and mechanical tests and of the chemical examination of a large number of samples of rubber prepared in connection with the scheme of rubber research arranged by the Government of Ceylon some years ago in conjunction with a number of planting companies in the island and with the Imperial Institute. Since 1920 this scheme has been co-ordinated with the rubber research scheme previously conducted in Ceylon by the Rubber Growers' Association, and a joint committee has been appointed by the Government to administer and control rubber research in the Colony. This Committee is under the chairmanship of the Director of Agriculture, and includes representatives of the Ceylon Government, the Rubber Growers' Association and planting companies. Substantial grants are being made by the Government of the Colony and by the Rubber Growers' Association. A number of local estate proprietors have agreed to subscribe, and steps are being taken to enlist the support of the entire planting community. A Committee has also been appointed in London and will supervise the investigations carried out at the Imperial Institute in connection with the scheme. The Director of the Imperial Institute is Chairman of the Committee,

which includes representatives of the Rubber Growers' Association, Ceylon planting interests and rubber manufacturers, etc. (see this BULLETIN, 1922, **20**, xxv). A number of technical officers, including a chemist, a mycologist, a physiological botanist, and a secretary and travelling inspector, have been appointed for work in Ceylon under the scheme, and detailed programmes for further work have been arranged. Certain investigations are already in progress and reports on work carried out in connection with the scheme will be published in this BULLETIN from time to time.

The following pages contain the results of the investigation of further earlier samples prepared under the scheme. The remainder of the samples will be dealt with in the next number of this BULLETIN, which will also contain a summary of the principal conclusions to be drawn from the whole of the experiments carried out since 1913.

SERIES V

The twenty-nine samples of rubber dealt with below form Sections 1 to 7 of Series V. They include specimens prepared in order to study further the effect (1) of smoking sheet and crêpe rubbers for different periods of time; (2) of converting the rubber into thin, thick and "blanket" crêpe; (3) of "overworking" the freshly coagulated rubber; (4) of rolling up sheet rubber in a wet condition followed by subsequent smoking for a short period; and (5) of allowing the latex to coagulate spontaneously. The rubbers included in Sections 8 to 16 of Series V and in Series VI are dealt with in this BULLETIN (1920, **18**, 1).

The following details relating to the preparation of these samples were supplied by Mr. L. E. Campbell, B.Sc., F.I.C., at that time Rubber Research Chemist in Ceylon:

The rubbers were prepared, not at Gikiyanakande, as in the case of Series I to IV, but on a Gampola estate, the elevation of which is about 1,600 ft. above sea level. The trees used for the experiments were situated at an elevation of 1,700 ft., and the majority of them were ten years old at the time of tapping. They were tapped with two cuts on one quarter of the circumference, and the

samples of rubber were made from the bulked latex. It was thought advisable to prepare the samples in accordance with the methods adopted on the estate in question, especially as they were intended to be repetitions on a commercial scale of the experiments of Series I and II.

Since 1913, when the majority of the samples of Series I and II were prepared, there has been a general reduction in the proportion of acetic acid used to coagulate latex; and whereas latex was formerly coagulated and machined on the day of tapping, it is now usually left to coagulate over night and machined the next morning.

The following table gives the average percentage of dry rubber in the latex at Gampola in different months, the figures being somewhat lower than those previously obtained at Gikiyanakande:

1916.	Percentage of dry rubber in latex.	1916.	Percentage of dry rubber in latex.
January	29·7	June	29·1
February	29·0	July	28·0
March	Not tapped	August	28·9
April	30·4	September	26·6
May	31·0		

The minimum amount of acetic acid necessary to coagulate a given volume of latex was rather lower than at Gikiyanakande, probably owing to the lower percentage of rubber in the latex. This minimum quantity of acid was approximately 1 part of pure acetic acid to 1,000 parts of pure latex, and this proportion of acid to latex was used in the preparation of the samples at Gampola. The latex was bulked and diluted, as in the previous series, so that it finally contained approximately 15 per cent. of dry rubber. In the preparation of the samples of sheet rubber the latex was placed in the usual pans and the requisite quantity of acid added in the form of a 5 per cent. solution. Next morning the sheets were rolled six times; five times through smooth rollers as in Series I and II, and once through diamond-pattern rollers, except in special cases, such as wet roll rubber, in which the use of the diamond roller was omitted.

The latex intended for the preparation of crêpe was placed in large tanks (Shanghai jars) and the requisite

quantity of acid was added. The coagulum was passed through rough rollers seven times and, when thin crêpe was required, once through smooth rollers.

Section 1.—Effect of smoking Sheet Rubber for Various Periods

Results of Examination

No.		Time of vulcanisation. *Mins.*	Tensile strength. *lb. per sq. in.*	Elongation. *Per cent.*	Permanent set. *Per cent.*
277	Unsmoked sheet. Control .	48	2,460	876	2·7
278	Sheet smoked for three days .	50	2,360	881	2·8
279	Sheet smoked for seven days .	47	2,350	878	2·7
280	Sheet smoked for fourteen days	50	2,470	887	3·3

Section 2.—Effect of smoking Sheet and Crêpe Rubber

Results of Examination

No.		Time of vulcanisation. *Mins.*	Tensile strength. *lb. per sq. in.*	Elongation. *Per cent.*	Permanent set. *Per cent.*
281	Unsmoked sheet. Control .	50	2,390	879	2·9
282	Smoked sheet. Smoked until dry—fourteen days . .	55	2,380	878	2·8
283	Crêpe. Air-dried . .	100	2,380	884	2·6
284	Smoked crêpe. Smoked five days	120	2,140	880	3·7

Remarks on Sections 1 and 2

With regard to the samples of smoked sheet rubber in Section 1, it will be seen that smoking for three, seven, or fourteen days has had no appreciable effect on the time of cure or the quality of the vulcanised rubber. The rubber smoked for fourteen days had the highest tensile strength of the smoked samples, being equal in this respect to the unsmoked control sheet.

In Section 2 the smoked sheet and crêpe required slightly longer times of cure than the unsmoked samples, the increase being from 50 to 55 minutes in the case of the sheet and from 100 to 120 minutes in the case of the crêpe. There was no difference in tensile strength between the unsmoked and smoked sheet (smoked for fourteen days), but the smoked crêpe (smoked for five days) gave a slightly lower figure than the unsmoked crêpe.

The results of the examination of previous samples of smoked rubber in Series I and II, Sections 11 and 15,

showed a marked increase in the time of cure of the smoked samples, and in some cases the smoked rubber was inferior in mechanical properties to the unsmoked sheet from the same latex. The previous results are shown in the following table:

	Serial No.	Time of vulcanisation. *Mins.*	Tensile strength. *lb. per sq. in.*	Elongation. *Per cent.*
SERIES I				
Section 11				
Smoked three days	66	95	2,390	871
Smoked seven days	67	105	2,260	865
Smoked fourteen days	68	105	2,050	868
Control	C 9	55	2,460	886
Section 15				
Smoked till dry (fourteen days)	87	128	2,020	853
Control	C 13	65	2,330	863
SERIES II				
Section 11				
Smoked three days	147	130	2,330	854
Smoked seven days	148	130	2,360	873
Smoked fourteen days	149	130	2,250	871
Control	C 20	67	2,500	855
Section 15				
Smoked till dry (fourteen days)	166	125	2,080	899
Control	C 20	67	2,500	855

The results given by the present samples show that smoking has not increased the time of cure appreciably, except in the cases of Nos. 283 and 284, and are therefore not in agreement with those obtained in Series I and II (Gikiyanakande), where the time of cure was nearly doubled by the smoking. At present no probable reason for this discrepancy in the results can be suggested. The question can only be elucidated by repeating the trials with further samples of smoked rubber from the two estates.

Section 3.—Effect of converting Rubber into Thin, Thick and "Blanket" Crêpe

Results of Examination

No.		Time of vulcanisation. *Mins.*	Tensile strength *lb. per sq. in.*	Elongation. *Per cent.*	Permanent set. *Per cent.*
285	Unsmoked sheet. Control	57	2,300	880	3·0
286	Thin crêpe	103	2,330	877	3·3
287	Thick crêpe prepared as No. 286, but not passed through smooth rollers	85	2,210	880	2·9
288	Dry thin crêpe prepared as No. 286, and rolled into thick or "blanket" crêpe	107	2,210	873	3·6

Remarks

In this section the thin crêpe No. 286 and the "blanket" crêpe No. 288 prepared from it show the usual lengthening of the time of cure due to the conversion of the rubber into thin crêpe, viz. 103 and 107 minutes, as compared with 57 minutes for the control sheet. The thick crêpe No. 287 cures rather more rapidly than the thin crêpe (85 minutes, as compared with 103 minutes), probably owing to the longer time required for drying. The tensile strengths of two of the present samples of crêpe (Nos. 287 and 288) are slightly less than that of the control sheet.

Similar differences in time of cure between thick and thin crêpe from the same latex have been observed in previous samples, as shown in the following table:

		Time of vulcanisation. *Mins.*	Tensile strength. *lb. per sq. in.*	Elongation. *Per cent.*
Thin crêpe	Mean of six samples in Series I and II	105	2,230	889
Thick crêpe	Mean of six samples in Series I and II	95	2,350	877
Thin crêpe	No. 261	105	2,470	889
Thick crêpe	No. 262	95	2,460	858
Present Samples.				
Thin crêpe	No. 286	103	2,330	877
Thick crêpe	No. 287	85	2,210	880

The present results, therefore, confirm those previously obtained, viz. that crêpe rubber requires a longer time for vulcanisation than the corresponding sheet, and that thick crêpe usually cures more quickly than thin crêpe.

Section 4.—Effect of Over-working Rubber

Results of Examination

No.		Time of vulcanisation. *Mins.*	Tensile strength *lb. per sq. in.*	Elongation. *Per cent.*	Permanent set. *Per cent.*
305A	Unsmoked sheet. Control	56	2,420	883	2·9
289	Rubber passed five times through rough rollers	110	2,280	883	3·3
290	Rubber passed ten times through rough rollers	120	2,260	877	3·2
291	Rubber passed twenty times through rough rollers	120	2,240	879	3·0

Remarks

The results show that, as usual, the conversion of the rubber into crêpe has lengthened the time of cure, but that the over-working of the rubber by passing it through the rollers an increased number of times has had no marked effect on the time of cure or on the mechanical properties of the rubber. The samples passed through the rollers ten and twenty times required a slightly longer time of cure than that passed through only five times. A slight increase in the time of cure with increased working was also noticed in Series I, samples Nos. 58, 59, 60, where the rubber was passed through the rollers seven, thirty-five, and seventy -times, and required 113, 115, and 130 minutes respectively; and in Series II, samples Nos. 144, 145, 146, which were passed through the rollers five, twenty-five, and fifty times, and required 105, 115 and 115 minutes respectively.

The present results agree with those previously obtained, and indicate that the amount of rolling which crêpe receives on plantations has no marked adverse effect on the rubber.

Section 5.—Effect of Various Amounts of Moisture in Sheet and Roll Rubber

Results of Examination

No.		Time of vulcanisation.	Tensile strength.	Elongation.	Permanent set.
		Mins.	*lb. per sq. in.*	*Per cent.*	*Per cent.*
292	Unsmoked sheet. Control .	47	2,430	878	3·2
293	Sheet smoked fourteen days .	55	2,370	882	2·7
294	Wet sheets rolled together in pairs and smoked three days	52	2,440	883	2·9
295	Wet sheets rolled together in threes and smoked three days	47	2,420	892	2·9
296	Wet sheets rolled together in sixes and smoked three days	45	2,400	878	2·4
297	Wet sheet rolled once, wound up, and smoked three days	45	2,370	878	2·7
298	Wet sheet rolled twice, wound up, and smoked three days	45	2,410	881	2·6
299	Wet sheet rolled four times, wound up, and smoked three days	50	2,410	880	2·4
300	Wet sheet rolled six times, wound up, and smoked three days	53	2,380	883	2·7

Remarks

The samples in this section were prepared in the form of sheet and wet roll and were subsequently smoked.

The sample of sheet (No. 293) which was smoked for fourteen days shows a slight increase in time of cure over the control sheet (55 minutes, as compared with 47 minutes).

The three samples of wet rubber (Nos. 294, 295 and 296) prepared by rolling together wet sheet in pairs, in threes, and in sixes, respectively, with subsequent smoking for three days, do not show any very appreciable difference in time of cure, the figures for the three samples being 52 minutes, 47 minutes, and 45 minutes respectively. The sample No. 296 prepared by rolling six sheets of wet rubber together would presumably remain in a moist condition longer than the other two specimens, and it cured in the shortest time. When examined at the Imperial Institute, No. 296 was found to lose 7·1 per cent. of its weight on washing and drying, this loss being principally moisture. The corresponding losses for samples Nos. 294 and 295 prepared by rolling sheets together in pairs and in threes were 1·0 and 3·2 per cent. respectively.

In the remaining four samples of wet rolled sheet, Nos. 297, 298, 299 and 300, which were passed respectively once, twice, four and six times through the rollers, wound up, and then smoked for three days, the amount of water left in the rubber would be successively diminished by the additional rolling, and when received at the Imperial Institute the samples lost respectively 4·2, 3·0, 3·1 and 1·6 per cent. of their weight when washed and dried. The results of the vulcanisation trials show an increase in the time of cure from 45 minutes for the once-rolled sheet to 53 minutes for the sheet rolled six times. The two intermediate samples, twice and four times rolled, cured in 45 and 50 minutes respectively.

No sample of unsmoked wet roll rubber was included in this set of specimens for comparison with the smoked wet rolls, but the results given by the latter agree generally with those obtained in Series III, Sections 4, 5*a*, 5*b*, 5*c*

and 6 (see this BULLETIN, 1918, **16**, 429), in which the samples containing the most water when rolled up cured in the shortest time.

It is not possible to state definitely whether a quick-curing rubber would be generally obtained by rolling up wet sheet and subjecting it to a short period of smoking in order to preserve it, as the control sample of this set of rubbers cured in an exceptionally short time. It seems probable, however, that such rubber would cure rapidly, as only the surface layers of a firm roll would be affected by the smoke. The present results show that wet roll rubber of excellent quality is obtainable by this method, which may be preferable to the alternative method previously suggested of adding alkaline creosote to the latex before coagulation.

Sections 6 and 7.—Spontaneous Coagulation

Results of Examination

No.		Time of vulcanisation. *Mins.*	Tensile strength. *lb. per sq. in.*	Elongation. *Per cent.*	Permanent set. *Per cent.*
301	Latex coagulated with acid .	120	2,220	887	3·6
302	Latex left to coagulate spontaneously. Coagulum removed after twenty-four hours from time of collection	115	2,300	871	3·6
303	Second coagulum obtained from No. 302 after seventy-two hours . . .	Too small for examination.			
304	Latex left to coagulate spontaneously . . .	88	2,250	884	2·7

Remarks

The three samples of thin crêpe forming Section 6 were prepared (1) by coagulation with acid in the usual way (No. 301); and (2) by spontaneous coagulation (Nos. 302 and 303). The latter samples were prepared from the same lot of latex, No. 302 representing the coagulum removed after 24 hours, and No. 303 the further coagulum obtained from the serum after 72 hours. The samples were all of pale colour and good appearance. Sample No. 303 was too small for detailed examination.

In Section 6 the thin crêpe rubber, No. 302, prepared by spontaneous coagulation, cured slowly (115 minutes),

thus resembling ordinary crêpe prepared by coagulation with acid rather than crêpe prepared from spontaneously coagulated latex, previous samples of which have cured more rapidly as a rule. In Section 7 the sample of crêpe No. 304, which was also prepared by spontaneous coagulation, cured in 88 minutes.

The following table gives the figures for Nos. 302 and 304 in comparison with the results obtained for previous samples of spontaneously coagulated crêpe rubber:

Crêpe from Spontaneously Coagulated Latex

No.	Time of vulcanisation. *Mins.*	Tensile strength. *lb. per sq. in.*	Elongation. *Per cent.*
175	65	2,370	890
176	67	2,490	891
177	75	2,560	894
266	80	2,280	884
271	70	2,230	875
302[1]	115	2,300	871
304[1]	88	2,250	884

[1] *Present samples.*

It is clear from these results that crêpe rubber of good quality can be prepared by allowing latex to coagulate spontaneously, thus avoiding the use of acetic acid. Such rubber, as a rule, cures more rapidly than crêpe made by coagulation with acetic acid.

It appears from the experiments on the spontaneous coagulation of rubber described in Section 6 that a little rubber separates from the serum after removal of the first coagulum after 24 hours' standing. This disadvantage could probably be overcome by using this serum for diluting a fresh batch of latex, or by the addition of a small amount of acetic acid to the liquid after the removal of the main bulk of the coagulum.

General Conclusions on Sections 1–7

A noticeable feature of the results given by these rubbers is the short time of cure of the control samples, viz. from 47 to 57 minutes. These times are much less than the average figure obtained for the control samples of the former Series I to IV made on Gikiyanakande Estate. Out of thirty-seven control samples previously examined, only two, Nos. C 9 and C 10, cured within the

above limits, requiring 55 and 57 minutes respectively, whilst the average time for all the earlier controls was about 70 minutes and the maximum time 95 minutes.

It should be noted that the times of cure of the present samples are not exactly comparable with those recorded for the previous series. The present samples were cured in an autoclave press at 50 lb. pressure (147·6° C.), whereas all the earlier samples were cured in a steam-jacketed autoclave at the same pressure. The time required in the autoclave press is, however, slightly longer than in the autoclave formerly used; for example, a rubber which cured in the autoclave in 50 minutes requires from 53 to 55 minutes in the press now used. It is therefore clear that this difference in treatment does not account for the results obtained.

It is difficult to assign a reason for the rapidity of cure of the present control samples, unless it is due to some inherent peculiarity of the latex from the particular trees used in these experiments. The only recorded difference in the method of preparation from that previously adopted is the use of a smaller amount of acetic acid for coagulation, viz. 0·10 part per 100 parts of undiluted latex, as compared with 0·20 part in the earlier samples. Previous samples of rubber coagulated with a "minimum" quantity of acetic acid, viz. 0·13 part per 100 parts of latex, did not differ in time of cure from samples of rubber prepared from the same latex by coagulation with twice this amount of acetic acid. It seems, therefore, that the rapidity of cure cannot be attributed to the amount of acid used for coagulation. It also appears improbable that the reduction in the time of cure was brought about by alterations in any of the other details of preparation, such as the method or time of drying of the samples, or that it would appear to be attributable to the age of the trees. The samples of Series I to IV were in general obtained from two groups of trees respectively 7 and 16–20 years old, whereas the present samples were derived from trees of an intermediate age, viz. 10 years. Moreover, a consideration of the results now obtained, as compared with those of the previous control samples, does not indicate that there is any

connection between the time of cure and the season of preparation or the percentage of rubber in the latex.

A further investigation of other samples of sheet rubber prepared from the latex from this group of trees will be necessary before it can be concluded that the quick rate of cure is a constant feature of the rubber obtained from these trees.

Series VII

RUBBER PREPARED BY THE BYRNE PROCESS

The samples of this series included specimens prepared by the Byrne process on an estate in Ceylon, and were forwarded for examination with a view to comparing this rubber with that obtained by the ordinary methods of preparation.

The samples were made from bulked latex, which was coagulated with acetic acid in the proportion of one part of pure acid to one thousand of latex.

Results of Examination

No.		Washing loss. *Per cent.*	Time of vulcanisation. *Mins.*	Tensile strength. *lb. per sq. in.*	Elongation. *Per cent.*	Permanent set. *Per cent.*
353	Plain lace crêpe .	0·2	131	2,180	869	3·5
354	Plain sheet . .	0·2	93	2,190	868	3·2
355	Byrne-cured lace crêpe . .	Nil	145	2,070	862	3·0
356	Byrne-cured sheet	Nil	85	2,240	874	3·0
357	Byrne-cured sheet made into "loaf" while wet .	0·7	70	2,460	880	2·4

Remarks

The results obtained with the samples forming this series show that the Byrne-cured crêpe required a longer time of vulcanisation and had a slightly lower tensile strength than the control crêpe (unsmoked); whereas, on the other hand, in the Byrne-cured sheet the time of vulcanisation was shorter and the tensile strength very slightly greater than in the unsmoked control sheet.

In the case of the loaf rubber made from wet Byrne-cured sheet the time of vulcanisation is much shorter than that of the control sheet, as would be expected with a wet rubber, and the tensile strength is the highest in the series.

It was found in previous experiments (see this BUL-

LETIN, 1916, **14**, 541, Samples Nos. 72–75, 102–104, 153–4, and 184) that samples of sheet, crêpe and worm block rubber prepared by the Byrne process required a longer time for vulcanisation, and gave on the whole a slightly lower tensile strength than the control specimens. It is, therefore, apparent that the rubber obtained by the Byrne process does not differ substantially in vulcanising and physical properties from that prepared by the ordinary methods.

SERIES VIII

The rubbers of this series were prepared at Culloden Estate by Mr. Campbell in collaboration with the Scientific Officer of the Rubber Growers' Association in order to determine the effect (1) of smoking rubber for various lengths of time; (2) of preparing rubber in the form of wet slab; and (3) of allowing the wet coagulum to "mature" for different periods. Samples of various estate grades of rubber were also included in this series.

Section 1.—Sheet Rubber smoked for Various Lengths of Time

Results of Examination

	Washing loss. *Mins.*	Time of vulcanisation. *Per cent.*	Tensile strength. *lb. per sq. in.*	Elongation. *Per cent.*	Permanent set. *Per cent.*
359 Control sheet (unsmoked)	0·1	85	2,400	872	2·8
360 Smoked three days	Nil	105	2,400	882	2·4
361 Smoked seven days	0·1	113	2,340	876	2·6
362 Smoked fourteen days	Nil	120	2,270	883	2·8

Remarks

The three samples of sheet smoked for 3, 7 and 14 days showed a gradual increase in the time required for vulcanisation as compared with the control sheet, the latter requiring 85 minutes and the rubber smoked for 14 days 120 minutes. Subjection of the rubber to 3 or 7 days' smoking did not materially affect the mechanical properties, but when the smoking period extended to 14 days, the tensile strength of the vulcanised product was distinctly lowered.

Another sample of smoked sheet in this series (No. 364 in the following section), which was smoked for three weeks, also required a longer time for vulcanisation than the control sheet (95 minutes compared with 73 minutes),

but in this case the tensile strength was virtually the same. In the latter respect, therefore, the results in the two cases are not in agreement.

The present results agree with those obtained previously with specimens of smoked rubber from Gikiyanakande (Series I and II), in showing that the smoking has produced a marked increase in the time of cure, although the increase is not so great as in Series I and II, where the time of cure was nearly doubled by the smoking. On the other hand, in later samples (Series V and VI) from another estate, it was found that the smoking had either no appreciable effect, or only a slight effect on the time of vulcanisation.

As pointed out on page 435, the reason for this discrepancy can be elucidated only by the examination of further samples of smoked rubbers from these estates.

In the previous samples the smoked rubber was in some cases inferior in mechanical properties to the unsmoked control sheet, and this is also true of the present samples.

Section 2.—Coagulum matured for Different Periods

Results of Examination

No.		Washing loss. *Per cent.*	Time of vulcanisation. *Mins.*	Tensile strength. *lb. per sq. in.*	Elongation. *Per cent.*	Permanent set. *Per cent.*
363	Control sheet (dry)	0·3	73	2,320	877	3·1
364	Smoked until dry. Three weeks	0·3	95	2,330	872	2·6
365	Coagulum not machined. Removed from serum at same time as Nos. 363 and 364 (wet slab)	2·45	79	2,170	890	2·7
366	Coagulum left in serum seven days (wet slab)	2·4	78	2,260	877	3·0
367	Air-dried crêpe	0·1	110	2,310	880	2·4
368	Vacuum-dried crêpe	0·07	125	2,210	862	3·9
369	Coagulum removed from serum after three days. Crêped and air-dried	0·2	97	2,320	878	2·4
370	Coagulum removed from serum after five days. Crêped and air-dried	0·05	100	2,270	872	2·6
371	Coagulum removed from serum after nine days. Crêped and air-dried	0·1	93	2,170	876	3·2
372	Coagulum removed from serum after nine days. Crêped and vacuum-dried	0·1	107	2,220	885	2·5

Remarks

The results obtained with the sheet and wet slab rubbers Nos. 363, 365 and 366 show that, contrary to the general rule for wet rubbers, both samples of slab required a longer time for vulcanisation than the dry control sheet. No explanation of this fact can be given at present. The slab rubber No. 366, left in the serum for 7 days, cured in the same time as No. 365, where the period of immersion was shorter. These rubbers were somewhat deficient in tensile strength as compared with the control.

In the case of samples Nos. 367 to 372, where the coagulum was allowed to remain in the serum for 3, 5 and 9 days and then crêped, comparison with the control specimens of crêpe shows that in all cases the air-dried crêpe made from the "matured" coagulum required a shorter time for vulcanisation, but the tensile strength was reduced if the coagulum was left in the serum for more than 3 days. In the case of the vacuum-dried crêpe, the tensile strength of the sample which was left in the serum for 9 days did not differ materially from that of the control sample, but the time required for vulcanisation had decreased.

In the case of the crêpe rubbers, therefore, the sample made from the matured coagulum invariably vulcanised more quickly than the control crêpe, but the differences were not very large. For example, the control air-dried crêpe (No. 367) required 110 minutes, and the quickest curing of the corresponding samples made from matured coagulum (No. 371, removed from serum after 9 days) required 93 minutes. The reduction in the time of vulcanisation in the case of the vacuum-dried crêpes was very similar, viz. from 125 to 107 minutes.

The effect of allowing the coagulum to "mature" for varying periods will be further considered in connection with later samples prepared in this way, which are included in Series IX and X.

Section 3.—Estate Grades

Results of Examination

No.		Washing loss.	Time of vulcanisation.	Tensile strength.	Elongation.	Permanent set.
			Mins.	*lb. per sq. in.*	*Per cent.*	*Per cent.*
373	Smoked sheet .	. 0·3	107	2,240	873	1·7
374	Vacuum-dried crêpe	. 0·3	135	2,270	870	2·7
375	Air-dried crêpe .	. 0·4	140	2,350	867	2·4
376	Scrap, Grade I .	. 1·1	100	2,050	845	3·1
377	Scrap, Grade II .	. 1·1	105	1,880	834	4·2
378	Lump rubber crêpe	. 0·4	127	2,350	870	2·6
379	Earth rubber crêpe	. 2·1	125	1,450	788	7·1

Remarks

The smoked sheet required less time for vulcanisation than the air-dried and vacuum-dried crêpe, as in the corresponding samples of Section 2, but in these estate specimens the tensile strength of the vulcanised product from the smoked sheet was lower than that from either the air-dried or vacuum-dried crêpe. As in Section 2, the vacuum-dried crêpe had a slightly lower tensile strength than the air-dried, but in this case there was only a small difference in the time of vulcanisation.

With reference to the scrap rubbers, the mechanical tests show that Scrap, Grade I, is of good quality and Scrap, Grade II, fairly good. The lump rubber crêpe is very good, whilst the earth rubber crêpe is rather poor. It is, however, to be noted that in this section of estate grade samples there was no control sample for comparison, and therefore it is not possible to discuss the results further.

Series IX

The samples of rubber in this series were prepared on Gikiyanakande Estate from latex obtained from the trees used for Series II. The samples represent for the most part repetitions of experiments previously carried out, and the methods of coagulation and preparation of the control samples and the specimens of sheet and crêpe were those described in the reports on Series I and II (this Bulletin, 1916, **14**, 498).

Section 1.—Effect of winding up Wet Creosoted Sheet Rubber

In addition to the control two samples of wet creosoted sheet rubber were prepared. In each case a mixture of crude wood creosote and normal caustic soda solution was added to the latex before the addition of acetic acid. The mixture, which consisted of 50 per cent. crude wood creosote by volume and 50 per cent. normal caustic soda solution, was added in the proportion of 0·25 cc. to every 100 cc. of pure latex.

Results of Examination

No.		Time of vulcanisation. *Mins.*	Tensile strength. *lb. per sq. in.*	Elongation. *Per cent.*	Permanent set. *Per cent.*
380	Control	73	2,180	885	3·1
381	Coagulum once rolled through machine, then wound up .	56	2,250	886	2·1
382	Coagulum rolled out in same way as control, then wound up	55	2,380	897	3·1

Remarks

The two samples of wet creosoted roll (Nos. 381 and 382) both cured much more quickly than the control sample, and were superior to the latter in tensile strength. In the earlier experiments (see Series I and II, Section 14, this BULLETIN, 1916, **14**, 544) the wet roll rubber also cured much more quickly than the control, but the tensile strength was unaltered or only slightly increased.

The difference in the amount of the mechanical rolling of the creosoted sheet, previous to winding it up into roll, had no effect on the rate of cure, but the roll made from sheet which had been machined five times (No. 382) had a greater tensile strength than that made from sheet machined only once (No. 381).

Section 2.—Effect of adding Alkaline Creosote to the Latex and allowing the Coagulum to mature for varying Periods before crêpeing

The creosote was added to the latex in the same way and in the same proportion as in Section 1 (see above).

Results of Examination

No.		Time of vulcanisation. *Mins.*	Tensile strength. *lb. per sq. in.*	Elongation. *Per cent.*	Permanent set. *Per cent.*
383	Control	72	2,300	880	2·6
384	No creosote added. Crêped just after coagulation .	135	2,240	858	2·7
385	No creosote added. Crêped after three days . .	79	2,250	877	2·4
386	No creosote added. Crêped after six days . . .	78	2,190	870	3·3
387	No creosote added. Crêped after fourteen days . .	73	2,170	877	2·7
388	No creosote added. Not crêped. (Slab) . .	66	2,220	872	2·0
389	Creosote added to latex. Crêped just after coagulation	139	2,240	861	3·0
390	Creosote added to latex. Crêped after three days .	97	2,260	866	2·3
391	Creosote added to latex. Crêped after six days .	79	2,130	862	1·9
392	Creosote added to latex. Crêped after fourteen days	90	2,110	856	2·1
393	Creosote added to latex. Not crêped. (Slab) . .	56	2,320	885	2·5

Remarks

This section includes two sets of samples, one of which was prepared with creosote and the other without.

In each case the effect of allowing the coagulum to mature before crêpeing was to reduce the time of cure. In the samples prepared without creosote (Nos. 384–8) the crêpe made just after coagulation required 135 minutes, whereas the samples crêped after 3, 6 and 14 days only required 79, 78 and 73 minutes respectively. The sample of slab rubber (No. 388) required 66 minutes, which is only a little lower than the time of vulcanisation of the control sheet. The tensile strength of all the samples was a little lower than that of the control sheet, but the variations were not so large.

The second set of samples, Nos. 389–93, to which creosote had been added, gave in general the same results, but the reduction in the time of cure was not so marked in the case of the samples crêped after varying periods of maturation as in the set without creosote. The slab rubber (No. 393), however, cured distinctly more quickly than the corresponding sample without creosote (No. 388).

These results agree with those previously obtained in showing that rubber allowed to remain in a moist condition has a quick rate of cure, and that the presence of creosote does not prevent, but may lessen, the effect on the time of vulcanisation. It is noteworthy that in samples Nos. 389–92 containing creosote, which were crêped within 14 days of coagulation, the reduction in the time of cure is less than in the samples without creosote, but that the slab rubber containing creosote cured more quickly than that without creosote. No definite conclusion as to the effect of creosote in slab rubber can, however, be drawn from this single comparison, especially as the slab rubber without creosote was slow curing and required 66 minutes, as against 72 minutes for the control.

Section 3.—Effect of adding Potassium Oxalate and Calcium Chloride to the Latex before Coagulation

Results of Examination

	Time of vulcanisation. *Mins.*	Tensile strength. *lb. per sq. in.*	Elongation. *Per cent.*	Permanent set. *Per cent.*
394 Control	72	2,370	884	2·4
395 Potassium oxalate added to latex. Rolled as controls .	65	2,370	866	2·9
396 •Calcium chloride added to latex. Rolled as controls	70	2,230	875	2·1
397 Potassium oxalate added to latex. Machine rolled once only	60	2,380	880	2·4
398 Calcium chloride added to latex. Machine rolled once only	58	2,230	865	3·0

Remarks

The results obtained with samples Nos. 395 and 396, which were prepared in the same way as the control sample, indicate that the addition of potassium oxalate has brought about a reduction in the time of cure from 72 to 65 minutes without affecting the tensile strength; whereas with calcium chloride the time of vulcanisation is scarcely affected, but the tensile strength is lower.

In samples Nos. 397 and 398, which were only rolled once, and therefore remained in a moist condition, the time of vulcanisation was almost equally reduced whether

potassium oxalate or calcium chloride had been added, and this effect is no doubt due to the maturation of the wet rubber. In this case also the tensile strength of the sample containing potassium oxalate was the same as that of the control, whilst that of the sample containing calcium chloride was lower.

Section 4.—Effect of adding old Latex Serum to fresh Latex before Coagulation

The old latex serum used in this experiment contained: Total solid matter, 1·8 per cent.; nitrogen, 0·06 per cent.

Results of Examination

No.		Time of vulcanisation. *Mins.*	Tensile strength. *lb. per sq. in.*	Elongation. *Per cent.*	Permanent set. *Per cent.*
399	Control	75	2,200	874	2·5
400	Old latex serum added to latex instead of water. Made into sheet in usual way	59	2,120	877	—

Remarks

The addition of old latex serum to the fresh latex has reduced the time of cure from 75 to 59 minutes without materially affecting the mechanical properties. It would appear, therefore, that old latex serum contains substances which have an accelerating influence on vulcanisation.

Section 5.—Effect of adding Caustic Soda to the Latex before Coagulation with Acetic Acid

Results of Examination

No.		Time of vulcanisation. *Mins.*	Tensile strength. *lb. per sq. in.*	Elongation. *Per cent.*	Permanent set. *Per cent.*
401	Control	75	2,370	881	2·4
402	Caustic soda added to latex in the proportion of 50 cc. normal solution to every litre of latex. Subsequently acidified with acetic acid .	105	2,210	862	2·7

Remarks

The effect of the addition of the caustic soda to the latex has been to increase considerably the time required for vulcanisation and to reduce the tensile strength

slightly. It was not stated how long the alkaline solution of the latex was kept before coagulating with acetic acid, and in the absence of full details no further comment is possible.

Section 6.—Effect of winding up Wet Creosoted Sheet

The creosoted rubber in this experiment was prepared as in Section 1.

Results of Examination

No.		Time of vulcanisation. *Mins.*	Tensile strength. *lb. per sq. in.*	Elongation. *Per cent.*	Permanent set. *Per cent.*
403	Control	72	2,430	890	2·1
404	Creosoted latex passed once through rollers. Sheet .	65	2,260	871	2·0
405	Creosoted latex passed once through rollers. Sheet wound up	56	2,470	866	1·7

Remarks

The creosoted sheet which was put through the rollers only once has a shorter time of cure than the control, and the tensile strength is lower. In the case of the wet creosoted sheet which was made into a roll there is a further reduction in the time of cure, due no doubt to the rubber remaining in a moist condition for a longer period, whilst the tensile strength is equal to that of the control.

Section 7.—Michie-Golledge Worm Rubber

Results of Examination

No.		Time of vulcanisation. *Mins.*	Tensile strength. *lb. per sq. in.*	Elongation. *Per cent.*	Permanent set. *Per cent.*
406	Control	62	2,300	880	3·6
407	Michie-Golledge worm rubber dried in hot air . .	106	2,220	864	1·6
408	Michie-Golledge crêpe rubber, as cut into worm for No. 407. Air dried . .	95	2,250	874	2·7

Remarks

The Michie-Golledge worm rubber dried in hot air had a much longer time of cure than the control sheet, and also than the air-dried Michie-Golledge crêpe, from which the worm rubber was cut. The mechanical properties of the three samples were approximately equal.

Previous results have shown that crêpe dried in hot

air up to a temperature of 140° F. required about the same time for vulcanisation as crêpe dried in the air at the ordinary temperature. The long time of cure required by No. 407 is, therefore, not easy to explain, but it may be noted that the temperature of drying was not stated.

The chemical composition of the three samples of washed rubber (control sheet, worm rubber dried in hot air, and crêpe dried in air) was practically identical.

Section 8.—Effect of rolling up Wet Sheet Rubber without Creosote

Results of Examination

No.		Time of vulcanisation. *Mins.*	Tensile strength. *lb. per sq. in.*	Elongation. *Per cent.*	Permanent set. *Per cent.*
409	Control	73	2,380	884	3·3
410	Sheets rolled together in pairs whilst wet. No creosote	62	2,320	881	3·0
411	Sheets wound up whilst wet. No creosote	55	2,510	898	4·4

Remarks

The sheets rolled together in pairs whilst wet had a shorter time of cure than the control sheet, but the mechanical properties were practically identical. The wet roll had a still shorter time of cure, and its mechanical properties were better than those of the control.

A chemical examination of the three samples showed that, whilst the percentage of caoutchouc remains practically constant throughout, the percentage of resin rises and the percentage of protein decreases in passing from No. 409 to No. 411.

Section 9.—Effect of adding Formaldehyde to the Latex

Results of Examination

No.		Time of vulcanisation. *Mins.*	Tensile strength. *lb. per sq. in.*	Elongation. *Per cent.*	Permanent set. *Per cent.*
412	Control	60	2,420	887	2·3
413	0·01 per cent. formaldehyde in latex	63	2,360	894	2·1
414	0·05 per cent. formaldehyde in latex	93	2,390	885	3·0
415	0·10 per cent. formaldehyde in latex	90	2,270	877	3·0
416	0·25 per cent. formaldehyde in latex	107	2,300	871	2·5

Section 10.—Effect of adding Formaldehyde to the Latex

Results of Examination

No.		Time of vulcanisation.	Tensile strength	Elongation.	Permanent set.
		Mins.	*lb. per. sq. in.*	*Per cent.*	*Per cent.*
417	Control	80	2,460	878	2·9
418	0·01 per cent. formaldehyde in latex	105	2,350	871	1·9
419	0·025 per cent. formaldehyde in latex	100	2,440	891	2·2
420	0·05 per cent. formaldehyde in latex	100	2,540	888	2·3
421	0·10 per cent. formaldehyde in latex	103	2,400	880	2·2

Remarks on Sections 9 and 10

In Section 9 the addition of formaldehyde has caused a lengthening of the time of cure. With 0·01 per cent. the effect is only slight, but with 0·05 per cent. and larger amount the increase in the time of cure is considerable. The tensile strength of the vulcanised rubber shows a slight reduction in the case of the samples containing the larger amounts of formaldehyde. The five samples were practically identical in chemical composition.

In Section 10 the formaldehyde has also increased the time required for vulcanisation, but the effect of 0·01 per cent. is much greater than in the previous section, and the addition of larger quantities of formaldehyde has not further increased the time of cure. In this set of experiments the mechanical properties of the vulcanised rubber have not been affected by the addition of 0·10 per cent. of formaldehyde to the latex. The chemical composition of the five samples of Section 10 was the same throughout.

Previous experiments with formaldehyde as a preservative have shown that its use lengthens the time of cure considerably, but does not affect the mechanical properties (see Series I and II, Section 4, Sub-section 3; this BULLETIN, 1916, **14**, 506; and Series III, Section 6, *loc. cit.*, 1918, **16**, 430). The results of the examination of the present samples, which were prepared with smaller amounts of formaldehyde than were used in the earlier experiments, support the previous conclusion.

The results indicate that if formaldehyde is used as a preservative only, the minimum amount should be added to the latex, as the addition of 0·05 per cent. lengthens the time of cure to an undesirable extent.

Section 11.—Effect of using Different Quantities of Acetic Acid for Coagulation

Results of Examination

No.		Time of vulcanisation.	Tensile strength.	Elongation.	Permanent set.
		Mins.	*lb. per sq. in.*	*Per cent.*	*Per cent.*
422	Control	63	2,450	885	2·4
423	Acetic acid. Minimum amount	63	2,500	916	2·1
424	Acetic acid. Four times minimum amount . . .	74	2,380	900	2·6
425	Acetic acid. Eight times minimum amount . . .	88	2,410	894	1·7

Section 12.—Effect of using Different Quantities of Formic Acid for Coagulation

Results of Examination

No.		Time of vulcanisation.	Tensile strength.	Elongation.	Permanent set.
		Mins.	*lb. per sq. in.*	*Per cent.*	*Per cent.*
426	Control	73	2,290	897	2·8
427	Formic acid. Minimum amount	71	2,340	877	4·4
428	Formic acid. Four times minimum amount . .	100	2,230	871	2·7
429	Formic acid. Eight times minimum amount . .	115	2,310	876	2·5

Section 13.—Effect of using Different Quantities of Sulphuric Acid for Coagulation

Results of Examination

No.		Time of vulcanisation.	Tensile strength	Elongation.	Permanent set.
		Mins.	*lb. per sq. in.*	*Per cent.*	*Per cent.*
430	Control	83	2,320	876	1·9
431	Sulphuric acid. Minimum amount	104	2,320	874	3·0
432	Sulphuric acid. Four times minimum amount . .	200	1,920	882	3·2
433	Sulphuric acid. Eight times minimum amount . .	200	1,905	892	3·3

Section 14.—Effect of using Different Quantities of Hydrofluoric Acid for Coagulation

Results of Examination

No.		Time of vulcanisation.	Tensile strength.	Elongation.	Permanent set.
		Mins.	*lb. per sq. in.*	*Per cent.*	*Per cent.*
434	Control	69	2,350	901	2·7
435	Hydrofluoric acid. Minimum amount	83	2,300	877	3·2
436	Hydrofluoric acid. Four times minimum amount . .	113	2,300	881	3·3
437	Hydrofluoric acid. Eight times minimum amount . .	149	2,340	885	2·9

Remarks on Sections 11 *to* 14

The samples included in these four sections were prepared in order to determine the effect of using excessive quantities of acid for coagulation. Acetic, formic, sulphuric and hydrofluoric acids were each used in minimum quantity to effect coagulation, and also in four and eight times that amount. The experiments were repetitions of those previously carried out, but larger excesses of acid were employed.

Acetic Acid (*Section* 11).—In the case of this acid, the use of four and eight times the minimum amount caused a lengthening of the time of cure without materially altering the mechanical properties of the vulcanised rubber.

Formic Acid (*Section* 12).—The sample prepared with the minimum amount of formic acid gave results practically identical with those of the control sample made with acetic acid. The use of four times the minimum amount of formic acid considerably increased the time of cure, and a further increase took place when eight times the minimum amount was employed. The mechanical properties of the rubber prepared with these larger amounts of acid were, however, not materially different from those of the sample prepared with the minimum quantity.

Sulphuric Acid (*Section* 13).—The use of sulphuric acid in minimum amount to produce coagulation has increased the time of cure in comparison with the control sheet from 83 to 104 minutes, and by using four and eight times

the minimum amount of acid the time of cure was nearly doubled, being 200 minutes in each case. The mechanical properties of the rubber, where the minimum amount of sulphuric acid was used, do not differ from those of the control sheet, but where four and eight times the minimum was employed, the mechanical properties show a decided deterioration, the tensile strength being much below that of ordinary commercial sheet.

Hydrofluoric Acid (*Section* 14).—With hydrofluoric acid in minimum amount the time of cure was increased to 83 minutes, as compared with 69 for the control sheet, whilst further increases were produced by the use of four and eight times the minimum quantity, the figures being 113 and 149 minutes respectively.

The use of hydrofluoric acid produced no alteration in the mechanical properties of the rubber as compared with the control, even where eight times the minimum quantity was employed.

General Remarks.—Comparing the action of the four acids, it is seen that they all cause an increase in the time of cure when used in four and eight times the minimum amount, but that the effect of an excess of acetic acid is not so great as that produced by each of the other acids. Sulphuric acid has by far the most marked effect, followed by hydrofluoric and formic acid, the minimum amount of formic acid causing no alteration in time of cure as compared with the control. Further, sulphuric acid when used in excess has an adverse effect on the mechanical properties of the vulcanised product, and in this respect differs from acetic, formic and hydrofluoric acids, which, when used in quantities of four and eight times the minimum quantity, do not cause any material alteration of the mechanical properties, as compared with the rubber prepared with the minimum quantities of acetic acid.

In previous experiments also acetic acid has been found to be the most satisfactory coagulant in comparison with the other three acids now under consideration. Previously only the minimum amount and twice the minimum amount of the respective acids were used, and it was found that while twice the minimum of acetic acid

caused no lengthening of the time of cure, that quantity of formic, hydrofluoric or sulphuric acid produced a decided increase.

In the earliest experiments (Series I and II, Section 1, this BULLETIN, 1916, **14**, 505) sulphuric acid, when used to the extent of twice the minimum quantity, did not produce a distinct effect on the mechanical properties of the rubber, but hydrofluoric acid had an adverse effect on the tensile strength. The latter result was, however, not confirmed by later experiments, in which hydrofluoric acid in quantity equivalent to twice the minimum did not materially alter the tensile strength of the vulcanised rubber as compared with the control sample. The present results for the samples prepared with hydrofluoric acid also indicate that the use of this acid even in four to eight times the minimum quantity has no effect on the mechanical properties.

The samples of rubber (washed) of Sections 11 to 14 were found to vary only slightly in composition, the caoutchouc figure being within the limits of 95·28 and 95·94, except in the case of the samples prepared with sulphuric acid and in one of the samples prepared with hydrofluoric acid.

The rubber made with four and eight times the minimum amount of sulphuric acid contained a higher percentage of resin, and the amount of caoutchouc was consequently lower than in the other samples by about 3 per cent. These two samples showed a marked inferiority in tensile strength.

The other sample which contained a low percentage of caoutchouc was prepared with eight times the minimum of hydrofluoric acid. This sample had a slightly higher percentage of resin and contained more mineral matter than the other samples.

EAST AFRICAN BAMBOO AS A PAPER-MAKING MATERIAL

In the article on the "Utilisation of Bamboo for Paper-making," published in this Bulletin (1920, **18**, 403), reference was made to the extensive forests of bamboo (*Arundinaria alpina*) that occur in Kenya Colony. The value of this bamboo has now been definitely ascertained as a result of investigations conducted at the Imperial Institute, and the local Government are prepared to issue licences to work two areas for the purpose of utilising the bamboo for paper-making. Full particulars of the conditions under which licences will be issued were published in *Official Gazette for the Colony and Protectorate of Kenya* for May 10, 1922. One of the areas is on the eastern slopes of the Kikuyu Escarpment Forest Reserve, and is bounded on one side by the main line of the Uganda Railway between Escarpment and Kijabe stations, and on the other by the Chania River. This area is capable of yielding approximately 40,000 tons of paper-pulp annually. The other area, which is capable of yielding half this amount, is on the north-eastern slopes of the Mau Forest Reserves, to the south of the main line of the Uganda Railway between Njoro and Elburgon stations. In each case the licensee will be given the exclusive right for twenty years to cut bamboos for the manufacture of paper-pulp. No royalty will be charged for a period of five years from the date of the licence, but subsequently a royalty per ton of air-dry unbleached pulp will be charged as tendered. The annual licence fee increases from £100 during the first five years to £2,000 in the tenth and succeeding years. The licensee must erect and complete a factory and subsidiary buildings within two years from the date of the licence, and the factory after that time must be worked for not less than 120 days in each year. After five years from the date of the licence the annual output of the factory must be at least 10,000 tons of pulp; and after ten years at least 20,000 tons. An area of forest will be set aside for the provision of wood fuel, on which a royalty is payable,

and, if possible, a sufficient area of grass land will be included in the licence to provide grazing for cattle used in connection with the operations of the licence. The system of cutting will be based on a ten years' rotation, that is to say, each block which has been worked over must be given a rest for ten years before it is cut again. This is necessary to prevent deterioration of the culms. Provision is made for the cancelling of a licence should certain conditions not be fulfilled.

Paper-making Trials

A consignment of about 1¾ tons of bamboo was forwarded by the Conservator of Forests in March 1920, and the results of laboratory trials carried out at the Imperial Institute and of trials on a commercial scale conducted by a firm of paper manufacturers are given in the following pages.

The consignment consisted of pieces of yellowish-brown bamboo about 20 ft. long and varying in diameter from 1½ to 2 in. The nodes were from 18 to 24 in. apart.

The bamboo was chemically examined with the following results, which are shown in comparison with corresponding figures for a well-known Indian bamboo (*Bambusa Tulda*):

	East African bamboo. *Per cent.*	*Bambusa Tulda* from India. *Per cent.*
Moisture	9·5	8·6
Matter soluble in water	3·6	2·5
Cellulose in material as received	47·5	53·4
Cellulose expressed on moisture-free material	52·5	58·4
Ash	1·2	4·1

The length of the ultimate fibres of the present material was from 1·6 to 2·7 mm., being mostly 2·0 to 2·6 mm., with an average of 2·3 mm. These measurements are practically identical with those of the ultimate fibres of *Bambusa Tulda.*

The results show that the East African bamboo resembles the Indian *Bambusa Tulda*, but contains a somewhat lower percentage of cellulose.

A sample of the bamboo was submitted to treatment at the Imperial Institute with caustic soda under conditions similar to those employed for the production of

paper pulp on a commercial scale, with the following results, which are expressed in each case on the material as received:

Trial.	Caustic soda used.		Conditions of boiling.		Caustic soda consumed per 100 parts of bamboo.	Yield of dry unbleached pulp expressed on material as received.
	Parts per 100 parts of bamboo.	Parts per 100 parts of solution.	Time.	Temp.		
			Hours.	°C.		*Per cent.*
A	16	4	7	160	10·6	40
B	20	4	7	160	11·6	34[1]

[1] *The yield of bleached pulp was* 31 *per cent.*

The pulp produced in Trial A was not completely broken up in the beater and could not be satisfactorily bleached, but the treatment in Trial B with a larger amount of caustic soda produced a pulp of good felting qualities, which could be readily broken up and furnished a pale brown paper of good strength. The pulp obtained in this trial was readily bleached and yielded a white paper of good quality; the amount of bleaching powder required was approximately equal to that used in the case of soda wood-pulp.

The yield of pulp was somewhat low as compared with that obtainable from the Indian *Bambusa Tulda* when treated in the same way and under the same conditions, but the results of the experiments showed that a good strong paper suitable for writing purposes could be produced. Arrangements were therefore made with a firm of paper manufacturers in the United Kingdom to conduct pulping trials with the bulk of the consignment, in order to determine the practicability of utilising the bamboo for paper manufacture on a commercial scale.

The firm who carried out the trials stated that about 1½ tons of the bamboo were heated with an extra strong solution of caustic soda for twelve hours, and furnished a pulp which bleached satisfactorily and yielded white paper of good quality. Although the nodes were not removed from the bamboos, the boiling and bleaching were effectively carried out. The pulp was converted into a pale-tinted paper, the yield of which (including loading and size) was found to be 41·23 per cent. of the weight of bamboo treated, which was considered satis-

factory. The paper was, however, somewhat soft, but could have been improved by longer beating.

The paper-makers regarded the bamboo as a promising material, but considered that some improvement would result from selecting the stems and keeping those of different ages separate from one another.

Specimens of the bamboos used in the trials and of the pulp and paper obtained may be seen at the Imperial Institute.

THE COMPOSITION OF DAWA-DAWA PODS FROM THE GOLD COAST

The dawa-dawa (*Parkia* sp., probably *P. filicoidea*, Welw.) is a leguminous tree reaching a height of 40 ft., the pods and seeds of which are used by the natives of West Africa as a foodstuff, in the same way as those of the better-known African locust (*P. globosa*, Benth.). It is found throughout the Northern Territories of the Gold Coast, where the wild plants are preserved by the natives, but it does not appear to be planted by them. Each tree yields about 120 lb. of pods annually, but the total amount available cannot at present be estimated. According to information supplied to the Imperial Institute by the Assistant Superintendent of Agriculture, there is a trade in the pods with the coast. The seeds are embedded in a yellow powdery substance, which is separated by sifting from the former after drying, and is then mixed into a paste with water and eaten by the natives under the name of "dozim." The kernels of the seeds are boiled in water to form a thick paste, which is placed in calabashes to ferment for three days; this product is used to flavour soup, the offensive odour which develops during fermentation being removed by roasting.

A quantity of the pods was furnished to the Imperial Institute by the Assistant Superintendent of Agriculture, Northern Territories, in order that the composition and value of the pods might be determined.

The pods were from 5 to 12½ in. (mostly about 9 in.) in length and from ½ to 1 in. in breadth. They varied in colour from pinkish-brown to dark brown.

The pod-case, which was tough and fibrous, enclosed

a soft, powdery, yellow material, in which were embedded a number of small seeds. The seeds varied in shape, some being oval and more or less flat, and others nearly spherical. They had tough, dark brown seed-coats and hard, greenish-yellow kernels.

The pods were found to consist of pod-case, 41·2 per cent.; powdery material, 33·4 per cent.; and seeds, 25·4 per cent. The three portions were examined with the following results:

Pod-cases.—It was stated by the Assistant Superintendent of Agriculture that in the Northern Territories the pod-cases are steeped for three days in cold water and the resulting liquor is used for binding floors. The examination of an aqueous extract of the pod-cases, prepared at the Imperial Institute, showed that it was not mucilaginous, but that it contained material of a pectic nature having adhesive properties. A quantity of tannin was also present.

Powdery Material and Seeds.—The powdery material and the seeds embedded in it were submitted separately to chemical examination in order to determine their value as foodstuffs. The results are shown in the following table, in comparison with those obtained with the combined powdery material and seeds from the pods of *Parkia filicoidea* from Nigeria, previously examined at the Imperial Institute:

	Present sample of dawa-dawa (*Parkia* sp.) from the Gold Coast.			Powdery material and seeds of *P. filicoidea* from Nigeria.
	Powdery material.	Seeds.	Powdery material and seeds.[1]	
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Moisture	13·7	10·1	12·14	9·35
Crude proteins	4·2	28·5	14·70	16·0
Fat	2·0	16·8	8·39	6·14
Sugars, reducing (expressed as dextrose)	19·2	nil	10·90	20·87
Sugars, non-reducing (expressed as sucrose)	8·5	3·5	6·34	1·53
Other carbohydrates (by difference)	35·8	28·9	32·83	30·33
Crude fibre	12·6	8·3	10·74	11·0
Ash	4·0	3·9	3·96	4·78
Nutrient ratio	1 : 16·2	1 : 2·5	1 : 4·7	1 : 4·2
Food units	79	146	108	108

[1] *Calculated from the figures in the two preceding columns and the relative proportions in which the powdery material and seeds occur in the pods.*

Neither the powdery material nor the seeds contained alkaloids or cyanogenetic glucosides.

The powdery material contained a large proportion of carbohydrates, of which somewhat less than half consisted of sugars; no true starch was present. The percentages of fat and proteins were very low.

The seeds contained about 17 per cent. of a semi-solid fat and a high percentage of proteins.

The contents of these dawa-dawa pods, *i.e.* the powdery material and seeds combined, were similar in composition to those of *P. filicoidea* pods from Nigeria, but differed in containing less reducing sugars and more non-reducing sugars.

The foregoing results show that the powdery material and the seeds of dawa-dawa pods, though different in character, are both of satisfactory composition as foodstuffs. The powdery material is of value owing to its richness in carbohydrates, and the seeds on account of their containing a high percentage of proteins and fat.

The percentage of fat in the seeds, although large when regarded as a constituent of a foodstuff, is probably not high enough to render them of commercial value as a source of fat.

A NEW OIL SEED FROM THE GOLD COAST

Among the products shown in the Gold Coast Section of the International Rubber and Tropical Products Exhibition held in London in 1921 and subsequently transferred to the Imperial Institute, was a sample of Kisidwe nuts. As no detailed examination of these nuts appears to have been made previously, it was considered desirable to ascertain the possibility of utilising them as an oil seed.

The nuts could not be definitely identified, but the Director of the Royal Botanic Gardens, Kew, to whom specimens were submitted, reported that they appear to be the seeds of a species of *Allanblackia*, probably *A. floribunda* (Nat. Ord. Guttiferæ).

The nuts, which were somewhat irregular in shape, varied from ¾ in. to 1¼ in. in length, and averaged about ¾ in. in diameter. They had a thin, brittle, reddish-brown woody shell, enclosing a kernel which was pale

brown internally. When cut or crushed the kernels had a slight fruity odour.

The nuts were found to consist of shell 38·4 per cent., and kernel 61·6 per cent. The average weight of an entire nut was 3·4 grams, and of the kernel 2·2 grams.

The kernels contained 1·9 per cent. of moisture, and yielded on extraction with light petroleum 71·8 per cent. of hard white fat, having a faint odour. The yield of fat is equivalent to 73·2 per cent. from the dry kernels or 44·2 per cent. from the entire nuts as received.

The fat was chemically examined with the following results:

Specific gravity at 100°/15° C.	0·8563
Refractive index at 40° C.	1·458
Melting point (open tube method)	38·6° C.
Solidifying point of fatty acids	57·6° C.
Acid value	1·0
Saponification value	190·8
Iodine value, *per cent.*	44·2
Unsaponifiable matter, *per cent.*	0·4
Volatile acids,[1] soluble	0·11
Volatile acids,[1] insoluble	0·10

[1] *Cubic centimetres of decinormal alkali required to neutralise the acids from 5 grams of oil.*

Solid fats of similar character to that obtained from these nuts have been obtained from the seeds of species of *Allanblackia* by previous investigators, and the foregoing constants agree generally with those recorded for the fat of *A. Stuhlmannii*, Engl.

The residual meal, left after the extraction of the fat from the kernels by means of light petroleum, was of a light golden-brown tint. It had a somewhat fruity odour and a bitter astringent taste. On analysis the meal was found to have the following composition, expressed on material containing 7 per cent. of fat:

	Per cent.
Moisture	9·3
Crude proteins	16·4
Fat	7·0
Carbohydrates (by difference)	52·2
Crude fibre	8·9
Ash	6·2
Nutrient ratio	1 : 4·2
Food units	111

The meal contained no alkaloids or cyanogenetic glucosides, but a small amount of tannin was present.

General Conclusions

Kisidwe nuts, if available in sufficient quantities, should be of commercial interest as an oil seed. The fat could probably be used for edible purposes, and in any case could be utilised for soap-making, but the residual meal could not be employed as a feeding stuff on account of its bitter astringent taste. This fact would tend to lower the commercial value of the nuts, but as the kernels contain a high percentage of fat they should realise a good price irrespective of the residual meal. The removal of the shell, which is thin and forms only 38 per cent. of the nut, would present no difficulty on an industrial scale.

THE UTILISATION OF LIME SEEDS

THE question of utilising the large quantity of seeds obtained as a by-product in the citrus industry of the West Indies was dealt with a few years ago by Dr. H. A. Tempany in "Notes on the Feeding and Manurial Value of Lime Seed," published in *West Indian Bulletin* (1916, 15, 27). The matter has again been taken up recently by the Department of Agriculture of the Leeward Islands, and a supply of oil obtained in the course of experiments conducted by Mr. A. E. Collens, F.I.C., F.C.S., Government Chemist and Superintendent of Agriculture, has recently been furnished to the Imperial Institute, together with a report on the investigation. At present, no use is made of lime seeds in the West Indies, apart from a very small quantity required for planting and a somewhat larger quantity used as litter in cattle pens. The bulk has to be disposed of as waste material, and as about 535 tons of the dried seeds are produced annually in Dominica alone, it will be seen that their disposal constitutes a problem of no little importance on lime estates. If an extended use could be found for the seeds it would not only remove this difficulty, but would afford an additional source of revenue to the lime industry, which is just now suffering from the deflated price of citrus products caused by the present period of world-wide depression.

Lime-seed Oil

The seeds used in the experiments at the Leeward Islands Laboratory had been washed free from pulp and air-dried before shipment. They were crushed in a hand machine, and the meal, after heating to 120° F., was treated in a small press. The oil so obtained was a somewhat turbid, greenish-yellow to light brown liquid, which, on filtering, became clear and brownish-yellow. The original ground seed contained 39·8 per cent. of oil, whilst the yield obtained by the methods used was 30 per cent.

The oil received at the Imperial Institute was a greenish-yellow, slightly cloudy liquid, with a bitter and unpleasant taste. A small amount of mucilaginous material was present.

The oil, after filtration, was found to have the following constants, which are shown in comparison with corresponding figures obtained by the Government Chemist:

	Present sample.	Figures recorded by Government Chemist, Leeward Islands.
Specific gravity	0·9236 at 15°/15° C.	0·9138 at 27°/15·5° C.
Refractive index n_D	1·4635 at 40° C.	1·4740 at 28° C.
Solidifying point of fatty acids	34·9° C.	—
Acid value	13·6	11·2
Saponification value	197·7	193·6[2]
Iodine value (Hubl., 17 hours) *per cent.*	109·5	100·75
Unsaponifiable matter, *per cent.*	0·4	0·72
Volatile acids, soluble[1]	0·27	—
" " insoluble[1]	0·48	--

[1] *Cubic centimetres of decinormal caustic potash required to neutralise the acids from 5 grams of oil.*

[2] *Calculated from the saponification equivalent given.*

The foregoing figures show that lime-seed oil is generally similar in chemical properties to cotton-seed oil, and experiments were therefore carried out at the Imperial Institute to ascertain whether, after refining, it would be suitable for edible use.

It was found that on refining with alcohol or caustic soda the oil lost its bitter taste. The treatment with caustic soda yielded a more palatable product than was obtainable by the use of alcohol, but the refined oil did

not in either case possess the bland taste required for edible oils.

Samples of the crude oil and the oil refined with caustic soda were forwarded to manufacturers for opinions as to their quality and probable value. They reported that the oil would not be suitable for refining owing to the inferior quality of the refined oil and the loss incurred in the process. The crude oil, however, would be quite suitable for soap manufacture, and could be used in admixture with linseed oil for certain industrial purposes. The crude oil should be saleable in moderate quantities in the United Kingdom if it could be offered at a price not exceeding £30 per ton c.i.f. (September, 1922).

Lime-seed Meal

Mr. Collens also investigated the composition of the residue left after the expression of the oil from the seeds. He found that the amounts of manurial constituents present in the meal from which 30 per cent. of oil had been extracted were as follows, his figures for the crushed whole seeds being given for comparison:

	Oil-pressed residue. *Per cent.*	Crushed seed. *Per cent.*
Nitrogen (N)	4·9	3·43
Potash (K_2O)	0·685	0·48
Phosphoric anhydride (P_2O_5)	1·05	0·74

These results show that the residual meal has a high manurial value. It is superior to the pen manure produced in the West Indies, and compares favourably with rape-seed cake, cotton-seed cake, and other oil-seed products used for manurial purposes.

The residual meal was examined by Mr. Collens as a feeding stuff, with the following results, which are again shown in comparison with the crushed whole seeds, and with undecorticated cotton-seed meal:

	Oil-pressed residues. *Per cent.*	Crushed seed. *Per cent.*	Undecorticated cotton-seed meal. *Per cent.*
Moisture	15·08	10·54	11·32
Crude proteins	30·50	21·37	23·75
Containing:			
True proteins	20·70	14·50	—
Fat	14·20	39·87	6·16
Carbohydrates	17·00	11·90	31·33
Crude fibre	20·05	14·10	21·80
Ash	3·17	2·22	5·64

It will be seen that the residual meal from lime seeds compares favourably in feeding value with undecorticated cotton-seed meal, for although containing less carbohydrates, it is richer in crude proteins. Mr. Collens states that the raw and crushed lime-fruit pulp is eaten with avidity by cattle and pigs, the latter being especially fond of the seed refuse. Both kinds of animals thrive on these products, and the milk obtained from cows in Dominica fed systematically on them is usually very rich and much above the standard adopted under the local Foods and Drugs Ordinance (viz., 3·0 per cent. of fat and 8·5 per cent. of solids not fat).

There would appear therefore to be no reasonable objection to feeding cattle and pigs on the residual meal from lime seeds, which could thus be utilised in the most economical manner. In the case of live-stock unaccustomed to feeding on lime products, the slightly bitter meal could be made attractive and palatable by admixture with molasses.

GENERAL ARTICLES

COTTON GROWING IN SWAZILAND

In December 1905 four samples of cotton were received at the Imperial Institute which had been grown on the Mawelawela Experimental Plantation of the Swaziland Corporation. The results of the examination were very encouraging, and it was recommended that efforts should be made to create a cotton-growing industry in Swaziland. Other samples received at later dates confirmed the view that cotton of good quality could be grown successfully in that country.

The following notes on the present conditions of the cotton industry in Swaziland have been supplied to the Imperial Institute by Mr. Herbert S. Parry, of Mafuteni, Umbuluzaan, Swaziland.

Natural Features

Swaziland lies between latitudes 25° and 28° S., and its eastern border is, roughly, from sixty to seventy miles from the Indian Ocean. For consideration from an

agricultural standpoint, it may be divided into three main belts running north and south.

To the west lies the mountainous High Veldt, of an average elevation of 4,000 ft., with an annual rainfall of 50–60 in. Frosts and periods of heavy mists occur here, and severe hail-storms are often experienced. This portion of the country is therefore quite unsuitable for cotton planting.

The central belt, consisting of Middle Veldt, has an average altitude of 2,000 ft., and a rainfall of 30–40 in. Large areas have been reported to be suitable for cotton culture.

The eastern belt is true Low Veldt, and consists largely of open bush country. The altitude ranges from 1,200 down to 700 ft. The rainfall varies according to the distance from the western hills, or the Lobombo range, to the far east, but is roughly from 15 to 30 in. per annum. This low veldt strip (especially the portion consisting of open undulating country), about 100 by 30 miles in extent, and with a rainfall of 28 to 30 in., has repeatedly been reported on by officers of the Department of Agriculture of the Union of South Africa and others as being specially suitable for growing cotton of first-class quality.

The fact that Swaziland immediately overlooks the fine harbour of Delagoa Bay should be of great advantage for future development.

Introduction and Development of Cotton Growing

Cotton has been grown experimentally in Swaziland at different periods during the past fifteen years with varying success, and reports on samples have been made by South African Government experts and by the Imperial Institute. These reports were, on the whole, favourable, although the cottons had sometimes been grown under unfavourable conditions and by planters with little or no previous experience. Among those who made such trials were Mr. A. M. Miller in 1905 and later years, Mr. Torrens at Balagana in 1909, and Mr. Parry in 1917.

The types planted in 1905 by Mr. A. M. Miller were Egyptian, Brazilian and Sea Island. These are the cottons referred to in the opening paragraph of this article,

and, in spite of mixture of seed and other imperfections, the reports, as already mentioned, were not unfavourable.

In 1909 Mr. Torrens grew five kinds of cotton in grey, sandy, alluvial soil; altitude, 1,200 ft.; average rainfall, 26 in. The following were the varieties grown and weights of lint obtained per acre: Bohemian, 447 lb.; Abassi, 94 lb.; Truitt's Big Boll, 517 lb.; Cook's Long Staple, 579 lb.; Russell's Big Boll, 435 lb. The yields of lint from the Upland varieties are very good. Mr. Torrens reported attacks by boll-worm, cotton stainer, leaf aphis and "triangular leaf disease," but none of these were serious.

In 1911 Mr. Sandeman, in the same locality, obtained 400 lb. of lint per acre over a 6-acre field. The seed used was Cook's Long Staple and Russell's Big Boll.

Two samples of seed-cotton grown by Mr. Parry in 1917 have been examined at the Imperial Institute. One was grown at Bremers Dorp and the other at Usutu. Both cottons were of the Upland American type, the lint in each case being of fair length and strength and of good character. They were regarded by brokers as of "fully good middling" grade, a type of cotton which is in great demand in Lancashire. The percentage of fibre obtained on ginning was very good, in one case amounting to as much as 36·7 per cent.

During the past few years, for various reasons, the yields have been inferior to those obtained by Mr. Torrens and Mr. Sandeman mentioned above, but nevertheless have ranged from 400 to 1,000 lb. of seed-cotton per acre; that is, about 130 to 350 lb. of lint.

In the district of Rustenburg, in the Transvaal, about 600 lb. of lint is the average yield per acre. It seems possible that two bales of seed-cotton per acre (1,000 lb. per acre) may become the standard in Swaziland, provided that better cultivation is practised and good seed employed.

Revival of the Industry

The high war prices naturally caused a revival of cotton growing in Swaziland in 1916. Unfortunately haphazard methods of obtaining seed and careless planting were the rule throughout South Africa.

In Swaziland, Griffin, King and Bancroft varieties were introduced, and often planted in quite unsuitable soils and localities.

It was not until March 1921 that several cotton growers in collaboration attempted to improve matters. They resolved to aim at two things: (1) The introduction of pure seed of suitable varieties only, and (2) the control of seed production (and of the industry generally) by the Administration of Swaziland acting under expert advice. The Administration was asked to promulgate certain simple cotton regulations based on the Uganda Cotton Laws, with the result that the High Commissioner issued the Swaziland Cotton Growing Proclamation in 1921, followed by Regulations under the Proclamation. These Regulations, which came into force on September 12, 1921, are summarised below. (An account of the regulations regarding cotton pests and diseases in other British possessions is given in this BULLETIN, 1922, **20**, 192.)

(1) It shall not be lawful to import into Swaziland any cotton plants or cotton seeds save under permit from the Resident Commissioner.

(2) All cotton plants shall be destroyed each year by a certain date, and all roots lifted by digging or ploughed under by a later date. Permits for an extension of time may be obtained on good cause being shown.

(3) No person shall grow cotton from seed not up to a certain standard of quality, to be determined by an officer appointed by the Resident Commissioner.

(4) The Resident Commissioner may requisition for redistribution any seed considered suitable for sowing, and before any grower may dispose of his supply of seed for sowing purposes he must submit a sample of his seed-cotton to the Resident Commissioner.

(5) Penalties, in the form of a fine or imprisonment and confiscation of cotton plants and seeds, may be imposed on any person contravening the Regulations.

Varieties Grown

The chief varieties at present grown are the following:

(*a*) *Griffin*.—This seed was obtained by the Administration from Natal from a prize-winning crop. The results

obtained, however, seem to be causing some disappointment through the cotton being of mixed length of staple.

(*b*) *Loffler's Zululand Hybrid*.—This is a fine quality of long-stapled cotton, which seems to suit the soil and climate of Swaziland.

(*c*) *Watt's Long Staple* (*Barberton*).—This is a long-stapled cotton bred at Barberton for a period of several years from a single plant. It is thought to be akin to Cook's Long Staple, and by careful selection and acclimatisation has developed into a strong-growing extremely prolific type.

Present Position of the Industry

In the season 1921–2 only about 350 acres of cotton were planted in Swaziland, as against 2,752 acres in the previous year, the aim of the growers being to produce their own seed for more extended planting in the following season.

It is felt that with the protection of the cotton laws, the introduction of more suitable seed, and increased experience, a good foundation has been laid upon which to build in the near future.

At present the greatest needs of the industry seem to be:

(1) A cash advance on the crop when ready for shipment and insured.

(2) The establishment of a ginning plant in Swaziland.

(3) A standard quality of seed for planting in Swaziland.

(4) A national system of grading throughout South Africa.

On January 20, 1922, a conference of cotton growers was held at Pretoria under the chairmanship of Mr. Scherffius, the cotton expert to the Union Department of Agriculture. The first and fourth of the above points were discussed, and no doubt some system will be devised to try to meet them.

Transport and Marketing Facilities

The position is unfortunate at present with regard to marketing facilities. The best cotton-growing areas lie

from fifty to one hundred and ten miles from the nearest rail-head. Waggon transport to rail-head costs from 3s. 6d. to 5s. per 100 lb. At present the nearest ginneries are at Durban or Pretoria. This entails a long journey involving a further cost on rail of between 23s. and 40s. per ton. If there were a ginnery in Swaziland, two-thirds of these heavy charges would be saved, as only the lint would need to be transported, the seed being kept in the country for use as cattle food and other purposes.

The present ginning and baling charges imposed by the South African Co-operative Cotton Growers' Association in Durban are ½d. per lb. of lint for ginning and ½d. per lb. for baling.

Cultural and Other Expenses

The cultural expenses in Swaziland are not great. Picking expenses compare favourably with those of other countries. Small children and girls receive 3d. and 6d. a day for picking, and can generally pick 25 to 40 lb. of seed-cotton per day. Others are paid 1s. for 30 to 40 lb., or 3d. for every 10 lb. picked. The total cost of raising cotton in Swaziland, from the time of ploughing to final sale in Manchester, that is to say the cost of seed, cultural expenses, picking, transport, railage and agency, ginning and baling, shipping and brokerage, works out at from 8d. to 10d. per lb. of lint.

These costs would be a good deal reduced by ginning in the country, and by better methods of handling and marketing. There is a possibility that in the near future a new railway may be made from the Rand to Delagoa Bay through Swaziland, by the renewal or alteration of the Mozambique Convention. This would be of enormous benefit to the industry, as it would then be possible to reduce the railage expenses, and to ship direct from Delagoa to England.

Local Use of Cotton Seed

Attention is now being given to feeding cattle with cotton seed straight from the gin for the production of prime beef. Careful experiments in this direction, carried out by the Swaziland Ranching Co., are giving promising

results, and the use of cotton seed as a feeding stuff should greatly assist the development of this branch of cattle industry.

Cotton growers at present produce far too small an amount of seed to make it worth while to consider the question of oil extraction.

Labour

The population of Swaziland, according to the census of 1921, consisted of 2,205 whites and 110,739 natives. The Swazi native is only an agriculturist to a very limited extent, inferior in this respect to the natives of Nyasaland, Kenya and Uganda. An attempt is now being made by the Administration of Swaziland to increase his efficiency by the formation of a small native experiment and training farm, with special reference to cotton culture. It will probably be some years before the natives become cotton-growers on their own account, their efforts at present being confined to raising food products on a limited scale. Large tracts of Swaziland are set apart for the exclusive use of natives, and these should prove valuable sources of labour for cotton picking.

Conclusions

Although the climate, soil and labour supply in Swaziland are entirely favourable to a greatly extended cotton-growing industry, there are two urgent needs to be provided: (1) a system of cash advances on cotton produced, and (2) adequate ginning facilities in the country. The growers realise that their main aim must be the establishment of a characteristic standard grade of cotton, which would be recognised on the home markets on the basis of its constancy of staple and general good qualities as "Swaziland Cotton."

PROPAGATION OF RUBBER TREES BY BUDDING

The low price which has been obtained for plantation rubber during the past few years has, in many instances, not equalled the cost of production, and this has directed

the attention of planters to means whereby the cost of producing rubber may be lowered. On examining the trees in certain existing plantations, and keeping accurate records of their latex yields, it has been found that many of the trees do not produce sufficient rubber to make the tapping of them worth while and that the bulk of the rubber is supplied by comparatively few high-yielding trees. It is obvious that this state of affairs involves a considerable waste of money and labour, since much more rubber could be obtained from the same area, and with the same amount of labour for tapping, if all the trees on any given estate were up to the standard of the high-yielding few. Competition will, in the future, force estates to produce cheaply, and one way of effecting a reduction in the cost of producing rubber is by planting only high-yielding trees. The trees in existing plantations have been raised from seed, in many cases without any very careful investigations as to the qualities of the parent seed-trees. It is found that seedling trees differ considerably from each other in latex-yielding qualities and, even when raised from seed obtained from high-yielding trees, the seedlings do not always inherit the good qualities of the parent trees in respect of yield. The only reliable method of propagating high-yielding trees is therefore by vegetative methods.

The usual method of increasing stock by vegetative propagation is by means of cuttings; but cuttings of *Hevea brasiliensis* do not root readily, and other methods have therefore to be adopted. Experiments carried out in Java, where the subject of the vegetative propagation of rubber trees was first considered, have shown that the most successful method is a form of grafting known as budding. This method is similar to that commonly employed in European nurseries and gardens for multiplying roses and fruit-trees. Briefly stated, the method consists in making a new plant by joining a portion of the tree possessing the desired qualities (the bud) to the root system of another individual (the stock). The trees that result from this process should have all the qualities of the parent tree, since they are really detached portions, and not the result of a generative process.

The budding process is simple, but the work requires practice before speed and neatness of execution, on which success largely depends, can be acquired. The principle underlying this practice is to bring the cambium layers of the bud and the stock together, so that when new growth takes place by the division of the cells of the cambium layers an organic union will be effected.

Stocks.—The stocks used for budding are seedling plants of *Hevea brasiliensis*, such as would be used for making plantations were the budding operations not carried out. It is best to plant these in nursery beds, as this facilitates the budding operations, but the budding may be done on similar stocks in the plantation if desired. The stock plants for budding should be raised from seed obtained from healthy trees with high-yielding qualities, and they should be strong, healthy plants, showing normal development. The nursery beds should be on the level and the soil should be well prepared by deep digging, and raised slightly above the paths. If any fungus growth is observed in the soil, a light dressing of lime should be applied. The seedling plants should be spaced at least 2 ft. apart in the beds, and a path about 3 ft. wide should be made at intervals of every two rows to provide the necessary space for carrying out the budding operation, and to prevent damage to the trees. Seedling stocks are suitable for budding when upwards of ½ in. in diameter at 6 in. from the ground: that is, when they are from six to eighteen months old.

Buds.—Only the best yielding trees should be used to supply the wood from which buds are obtained, and it is advisable to obtain all the buds from one mother tree, or from as small a number of individuals as possible, since this will give plants of uniform type. Buds taken from the thinner branches should be used for young stocks, and from thicker ones for larger plants; a rough guide to suitable material being the thickness of the bark, which should correspond as nearly as possible with that of the stock. The bark of the wood selected should peel readily, as otherwise it will be difficult to detach the bud from the wood; the trees must therefore not be in

a dry or resting condition when the wood is taken. The branches of selected wood may be cut into 2 to 3 ft. lengths for convenience of transport; and they should be kept fresh by being stood in a few inches of water in a clean kerosene tin and shaded from the sun. It is estimated that from 700 to 1,000 buds can be procured from one well-grown mother-tree.

Tools and Materials.—The ordinary pocket-knife, provided it has a keen edge and a pointed end, will serve to cut the buds from the wood, but special budding knives are available for those who prefer them. These latter are provided with a flat elongated bone handle, which is employed for lifting the bark of the stock before the bud is inserted. In addition to the knife, tying material is required to keep the bud and the stock together until new growth has effected a union. The material found best suited to this purpose in Java consists of thin cotton cloth dipped into melted paraffin wax and then torn into thin strips. A piece of the cloth about 16 in. wide by 3 ft. long can be torn into about seventy strips by first cutting it along the edges with scissors at about ½ in. intervals. The wax should have a rather low melting point, so that after the tying is completed the bandage can be smoothed down with the knife and made watertight. As a certain amount of latex exudes during the budding operation and cleanliness is necessary to ensure success, a piece of cotton cloth should be available for wiping the hands of the operator and for cleaning the knife after each stock is budded.

The Budding Operation.—It is best to carry out the budding operation on a definite plan, as by this means speed is acquired, and quickness of execution is essential to success. The first operation is to clean the base of the stock by wiping off any grit or soil that may adhere as the result of heavy rains. The bud is then removed from the branch of the bud-wood by first making two longitudinal cuts on each side of the bud and about ⅝ in. apart, and then cutting out the bud by passing the knife below it well into the wood. The portion of bark thus removed has the bud approximately in the centre, is shield-shaped, measuring about ⅝ in. wide and 2 in. long,

with a piece of wood adhering on the underside (see Fig. 1). The bud at this stage is conveniently held between the lips of the operator, and is thereby kept from contact with the soil. The stock next receives two parallel vertical cuts in the bark down to the wood about ¾ in. apart near the base. The bud is now prepared for insertion by having the portion of wood removed from the underside and by squaring off the portion of the bark above the bud so as to fit the horizontal cut in the stock. It is necessary

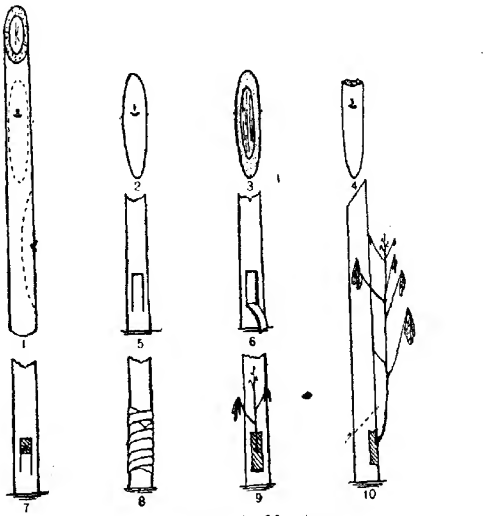


FIG. 1.—Budding of rubber trees.

1. The bud *in situ*; the dotted lines indicate the portion of bark to be removed with the bud. 2. The bud removed. 3. The underside of the bud with a portion of wood attached. 4. The bud ready for inserting in the stock. 5. The stock, showing two vertical cuts in the bark joined by one horizontal cut. 6. The tongue of bark turned back for the insertion of the bud. 7. The bud in position with the tongue of bark shortened and replaced. 8. The bandage in position. 9. The bandage removed, and the bud commencing growth. 10. Further growth from the bud; the dotted line indicates the point at which the stump should be cut.

to take care when removing the wood from the underside of the bud not to detach with it the core from the bud itself, as, if this is done, the bud cannot develop a shoot, even although a successful union of the cambium layer with that of the stock takes place. The two vertical cuts in the stock are then joined at the top by a horizontal cut. By inserting the handle of the budding knife into one corner where the horizontal cut joins one of the verticals the tongue of the bark formed by the

three cuts is lifted and turned back. The stock is now ready to receive the bud. It is not necessary that the bark on the sides of the bud should exactly fit the opening in the stock, and it is advisable for it to be slightly smaller as this allows of latex draining away, which might otherwise coagulate beneath the bud and prevent a union between it and the stock. The upper edge of the bud shield, however, should be in contact with the horizontal cut edge of the bark of the stock. After the bud has been inserted, the tongue of the bark which was turned back should be replaced, but it should be shortened by cutting off a portion so as not to cover the bud. When this has been done, the whole should be tied together by means of the strips of waxed cotton cloth above referred to. These should be put on in the same way as a surgical bandage or puttees; that is, starting from below and finishing at the top. The bandage should be smoothed down with the knife after the operation so that the wax may form a watertight covering.

To recapitulate, the operation is best carried out in the following order, namely: (1) Cleaning the stock; (2) cutting the bud from the wood; (3) making two vertical parallel cuts in the stock; (4) removing the wood from the underside of the bud; (5) making the horizontal cut in the stock joining the two vertical cuts; (6) inserting the bud; (7) tying the bandage.

The best time of the year for carrying out budding is at the commencement of the rains or during moderately rainy weather, as then the bark is in the best condition for the operation. Too much rain is likely to cause fungus growths, whilst dry weather renders the bark of both bud-wood and stock difficult to manipulate.

After Treatment.—In about twenty to twenty-five days after the budding operation the bandage may be removed and the loose tongue of bark covering the inserted bud may be cut off. After a further interval of about ten days the inserted bud should be examined, and if, on making a slight scratch on the bark of the patch above or below the bud, it is found to be green and healthy, it may be assumed that the operation has been successful and that a union of the bud and stock has taken place.

In this event the stock should be cut down to about 1 ft. above the point where the bud was inserted. Should the bud have failed to unite with the stock, another bud may be inserted on the opposite side, in the manner already described.

The result of cutting back the stock is to induce the inserted bud to break, but it sometimes also has the effect of causing shoots to develop at the base of the stock below the bud. All shoots other than that from the new bud should be carefully removed at an early stage. When the new bud has developed into a shoot an inch or so in length, the plant should be lifted from the nursery beds and planted in permanent quarters in the plantation. As soon as the new shoot has attained a height of from 3 to 4 ft., which it will do in from five to six months after planting, the portion of the stock which was left above the bud should be removed. This is best done by means of a small-toothed saw. Care must be taken not to injure the new shoot during this operation, and as a protection a thin piece of wood or tin should be held between the shoot and the stump whilst the latter is being sawn off. An oblique saw-cut should be made sloping outwards from the top of the bud at an angle of about 45°. The bark of this wound should be cut smooth with a knife, and afterwards a coat of melted paraffin wax should be applied.

Advantages of using Budded Trees.—It has been observed at the West Java Experiment Station that budded trees up to the age of four years have developed a much larger number of latex vessels than seedling trees of a similar age, and this would appear to confirm the opinion that the characteristics of the parent tree are retained by the budded trees. It would seem desirable, therefore, to employ only budded trees for making new plantations or to replace low-yielding trees in existing plantations. It has also been proved that seedling plants are variable and of different types even when the seeds from which they are grown have been derived from high-yielding parent trees; and as it takes some years for seedling trees to prove their true character, much money and trouble would be saved by planting trees derived

from buds obtained from high-yielding parent trees, since these can be relied on to become high-yielders on reaching maturity.

CULTIVATION OF THE AFRICAN OIL PALM IN SUMATRA

In an article on "The Cultivation of the African Oil Palm, with Special Reference to the East Indies" (this Bulletin, 1920, **18**, 209), an account was given of the oil palm plantation industry of Sumatra, which was based on two papers published by Dr. A. A. L. Rutgers, Director of the General Experiment Station of the A.V.R.O.S. (Algemeene Vereeniging van Rubberplanters ter Oostkust van Sumatra).

A well-illustrated monograph of 125 pages has now been issued by the A.V.R.O.S., which is entitled *Investigations on Oil Palms made at the General Experiment Station of the A.V.R.O.S.*, and has been compiled by Dr. A. A. L. Rutgers, in collaboration with Ir. H. N. Blommendaal, Ir. Jhr. F. C. van Heurn, Dr. C. Heusser, J. G. J. A. Maas, and Dr. C. Yampolsky. This publication can be obtained from the Experiment Station, A.V.R.O.S., Medan, Netherlands India, price 10s.

In view of the growing importance of the subject and the great interest now being evinced in oil-palm cultivation, it has been considered that it might be of service to prepare a brief summary of the contents of the monograph, and particularly of those portions which shed new light on the development of the plantation industry.

Chapter I. The History of the Oil Palm in Netherlands India, by Dr. A. A. L. Rutgers.

The establishment of oil-palm plantations in Sumatra was commenced in 1911 by a Belgian firm (the Hallet undertaking), and within four years 6,500 acres had been planted. The plantations were made at various localities on the east coast of the island, including Poeloe Radja in the southern part (Upper Asahan), Deli Moeda in the centre, and Soengei Lipoet in the north (South Achin). Extension was delayed owing to the European war, and at the beginning of 1917 the area devoted to the oil palm

was still only 6,500 acres. Since that time, however, the industry has developed rapidly and oil palms are now to be found on the east coast on nearly every type of soil and at altitudes ranging from 30 to 1,500 ft. By January 1, 1918, the area had increased to 8,500 acres, two years later to 17,100 acres, and by January 1, 1922, no less than 28,067 acres had been planted.

The oil palms in the plantations in the Dutch East Indies are derived from the seed of four trees grown in the Botanical Gardens at Buitenzorg, Java, two of which were sent from Mauritius in 1848, and the other two from the Hortus Botanicus at Amsterdam in the same year. All the oil palms in the Dutch East Indies are, however, of a uniform type in spite of their having originated from plants from two different sources. The probable explanation of this fact is that the plants received at Buitenzorg from Amsterdam belonged to the same lot as those received from Mauritius, and that plants were sent from Mauritius to both Amsterdam and Buitenzorg at the same time. Moreover, the common type of oil palm in Sumatra, spoken of as the "Deli" type, is identical with that of the trees growing in the Economic Gardens at Buitenzorg, which were raised from seed from the Botanical Gardens. There is little doubt, therefore, that the palms growing at Buitenzorg and those in Sumatra had a common origin. The statement that the seed planted on the St. Cyr estate in 1884 was derived from Singapore (cf. this BULLETIN, 1920, **18**, 241) is now considered to be probably inaccurate and reasons are adduced for regarding it as more likely that the St. Cyr trees are also the offspring of the Buitenzorg trees.

The Deli type is a good form of *Elæis guineensis*, Jacq., var. *dura*, and is quite satisfactory as regards yields and the purity of the seed. The amount of shell, however, is rather high, and forms 30 per cent. of the weight of the fruit.

Chapter II. Varieties in the Oil Palm (Elæis guineensis, Jacq.), by Cecil Yampolsky.

A fairly complete collection of the varieties of *Elæis guineensis* has been secured for selection work at the General Experiment Station of the A.V.R.O.S., and a

preliminary classification has been made which is based on the thickness of the shell of the nut and is nearly identical with the classification of E. Annet in *Le Palmier à Huile au Cameroun et en Afrique Tropicale* (Paris, 1921). Four main varieties are distinguished.

A. Var. *macrocarya*, the thick-shelled type, the shell being 4 to 8·5 mm. thick and constituting about 50 per cent. of the weight of the fruit. The pericarp is thin, varying from 0·75 to 2·5 mm. This form is sometimes termed the "Congo type." The kernels are of widely varying dimensions.

B. Var. *dura*, the ordinary type, with a shell 2 to 5 mm. thick and forming about 30 per cent. of the weight of the seed. The pericarp is 2 to 6 mm. in thickness. This includes the Deli type, to which most of the palms on the east coast of Sumatra belong. The kernels are of various dimensions.

C. Var. *tenera*, the thin-shelled variety, with a shell 1 to 2·5 mm. thick and constituting about 10 per cent. of the weight of the fruit. The pericarp varies greatly in thickness and the kernels are of various dimensions. This is the "Lisombe type."

D. Var. *pisifera*, the shell-less form. The kernels are very small, about the size of a pea. The pericarp is thick, but the whole fruit is small. This type may, perhaps, be abnormal.

In addition to these four varieties, mention is made of the "diwakkawakka" form, in which the pericarp is surrounded by a mantle (containing oil) which is said to be composed of six accessory sterile carpels. This type has been described by Annet as *Elæis Poissoni*. The fruit consists of mantle pulp, 50 per cent.; pericarp pulp, 34·5 per cent.; shell, 11 per cent.; and kernel, 4·5 per cent.

The other varieties mentioned in the literature were not taken into account, as it was evident that they would probably be of little importance for the selection experiments being carried out at the Experiment Station of the A.V.R.O.S. This selection work is still in progress, but has already given the following results.

Trials with four lots of Lisombe seed imported from

Africa resulted in each case in the production of a mixture of good and bad forms. The thick-shelled *macrocarya* was invariably present and, in two cases, nearly the whole of the offspring was of this form. The ordinary *dura* type was also present in every case, but in varying proportions. The thin-shelled *tenera* was represented by large numbers in two of the lots, but was nearly absent in the other two. The shell-less or *pisifera* type occurred in one case only.

Similar results have been obtained at Buitenzorg, imported seed always giving a mixture of different forms; in several cases there was a preponderance of the inferior types.

It is therefore inadvisable to plant large areas with imported seed, and the Deli type must remain the standard form for the east coast of Sumatra until a better form has been established by selection work with the offspring of newly imported varieties.

The General Experiment Station of the A.V.R.O.S. is working in two directions to improve the oil palms of Sumatra. In the first place, an endeavour is being made to remove all the thick-shelled (*macrocarya*) forms from the trees grown in the seed gardens from imported seed. Every tree with thick-shelled nuts is rigorously removed in order to prevent the dissemination of this type. The planters in Sumatra are co-operating with the Experiment Station in this work, as they are fully cognisant of the risk of the deterioration of the Deli type by the presence of these undesirable forms. Secondly, an effort is being made to develop a variety with a low percentage of shell, a high total yield, and breeding true to type. A number of trees have already been selected of the thin-shelled (*tenera*) type, which bear fairly large fruits with a low percentage of shell and a large kernel. The bad types will be removed from the offspring of these trees so that fertilisation will only be possible between the good types. Attempts are also being made to obtain seeds by artificial self-pollination, in order to hasten the production of a pure strain of the desired type.

The Experiment Station has imported seed of nearly every type mentioned in the literature, and the best

types of the Lisombe (*tenera*), the shell-less (*pisifera*), and the diwakkawakka form are to be used as a basis for future selection work.

Chapter III. Planting of Oil Palms, by J. G. J. A. Maas.

In selecting seed for sowing, the planter should choose trees (of the Deli type) which yield as large a total amount of pericarp as possible—*i.e.* trees which produce numerous fruits with a large percentage of pericarp—and from these select only such as bear the best type of fruit.

The chance of obtaining good offspring can be increased by artificial pollination.

Volunteer plants should not be used as they usually develop unsatisfactorily.

In selecting seed for sowing, good ripe fruit should be chosen. Fruit which does not fall from the bunch, but is easily freed from it, germinates more rapidly than somewhat over-ripe or unripe fruit. Experiments have indicated that fruits which have been picked by hand from the bunches have the best germinating power. The seed of such fruits germinates most quickly when sown as soon as possible after the fruit has been gathered. Seed imported from Africa germinates very slowly, and seed from Java germinates more slowly than fresh seed produced in Sumatra. Imported seed is generally received in the form of nuts, and these germinate best when they have been so packed as to prevent excessive drying. The most satisfactory method is to pack the nuts in a moist mixture of charcoal and sand, but almost as good results are obtainable from nuts which have been coated with paraffin wax and packed in paper or wood shavings.

The nuts germinate more quickly than the whole fruits, but generally, under ordinary conditions, only about 50 per cent. germinate within nine months. As this slow germination hinders the development of a plantation, experiments have been made to devise means of hastening it. Several methods of effecting more rapid germination have been discovered, such as fermentation, treatment with warm water, with water saturated with chloroform, or with water containing alkali or acid. In general, heating the seed has been found the most satisfactory method. Seed kept for two weeks in pits in which the

temperature rose to nearly 40° C. gave a germination of 60 to 80 per cent. within three to four months. By placing the seed, after heating, in cold water, which was changed every day, a germination of 86 per cent. was obtained in three months after planting. Another method, which gave rather better results, was to place the seed, after heating, in water which was heated every morning to 40–45° C. and then allowed to cool. Good results have also been secured by placing the nuts in a shallow pit between layers of stable manure or a mixture of oil palm fruit pulp and stable manure. Whole fruits, which had been wrapped in a wet sack and placed for five days in a zinc-lined chest at 40°–50°, gave a germination of 77 per cent. within 100 days.

Annet has recommended planters in the Cameroons to ferment the fresh fruit for eight days in some receptacle before sowing. During the fermentation the temperature rises to 60–70° C. It is considered in Sumatra, however, that this temperature is too high and that the most reliable results are obtained by not heating above 40° C.

The methods of raising the plants and transplanting them are discussed. As the result of numerous observations, it is concluded that a spacing in the plantation of about 9 by 9 metres (or 30 by 30 ft.) is sufficient for oil palms growing under good conditions. In a quadrangular system of planting there would then be 123 trees per hectare (49 per acre) or in a triangular system 143 trees per hectare (57 per acre).

Chapter IV. The Upkeep of an Oil Palm Plantation, by J. G. J. A. Maas.

With regard to inter-planting, it is stated that Robusta coffee has been planted on a large scale between the oil palms on the east coast of Sumatra, and that there appears to be no objection to this practice in situations possessing conditions similar to those of a rubber plantation in which coffee could advisedly be grown between Hevea trees.

The planting of cover crops is recommended in preference to clean weeding. For this purpose, *Mimosa invisa* and *Centrosema Plumeri* are recommended among creeping plants and *Tephrosia candida* and *Crotalaria usaramoensis* among erect plants.

Measures to be taken to prevent soil washing are described, and it is pointed out that these will vary according to the contour of the land and the character of the soil.

With reference to the question of manuring an oil palm plantation, it is estimated that in the formation of the leaves and bunches of fruits the quantities of food constituents extracted from the soil per hectare per annum amount to 131 kilos. of nitrogen, 204–250 kilos. of potassium and 40–65 kilos. of phosphorus, corresponding respectively to 117, 182–223, and 36–58 lb. per acre. Until recently, in the clean-weeding system which was adopted, the leaves and the remains of the bunches and pulp were not returned to the soil, and hence the greater part of the large quantities of plant food extracted from the soil did not become available again for the palms. It is therefore of great advantage that green manures are now being increasingly planted, as this will probably entirely compensate for the nitrogen taken from the soil. In order to supplement the supply of other constituents, the ashes of leaves, pulp residues and fruit stalks should be returned to the soil, together with other plant ashes, if available. Special experiments are needed to ascertain whether artificial manures could profitably be applied.

An account is given of pruning experiments started in 1919 on the plantations of Mata Pao and Poeloe Radja. Rutgers (see this BULLETIN, 1920, **18**, 235) says that pruning should be restricted to the leaves which it is necessary to remove for harvesting the bunches. The results of the experiments confirm this view and show that the minimum of pruning gives the best results. It is not necessary to trouble about the pressure of the leaves on the swelling bunches, and this is especially the case when artificial pollination has been practised. It has been found that the total fruit production of heavily pruned trees decreases much more rapidly than that of normally pruned trees.

Chapter V. Artificial Pollination of the Oil Palm, by Dr. C. Heusser.

In order to study the economic effect of artificial pollination, an experiment was commenced on the Mata Pao estate in October 1920. Of two plots, each of

7 hectares ($17\frac{1}{2}$ acres), the trees on one were artificially pollinated at intervals of three days, whilst those on the other were left to natural pollination. The result showed that in the first two harvests the total crops of fruit from the two plots were 8,817 and 3,416 kilos. respectively, the artificial pollination thus giving an increase of 158 per cent. The experiment is being continued in order to obtain trustworthy figures.

The pollen should be collected at 3 p.m., as at this time of day the atmosphere is dry. It is best stored in glass-stoppered jars containing quick-lime. A convenient apparatus for pollinating the flowers is described, which consists of a form of spraying flask or atomiser. It is estimated that from 500 to 1,000 trees, in which the inflorescences can be reached without a ladder, can be pollinated by one worker in a day of eight hours, but where a ladder has to be used a longer time is necessarily required.

Chapter VI. Estimating the Age of Oil Palms, by J. G. J. A. Maas.

In this chapter a method is described for estimating the age of an oil palm by counting the leaves and leaf-bases. The number of leaves produced per annum by the oil palms on the east coast of Sumatra is from 20 to 24, but after the fifteenth year the number slowly decreases.

Chapter VII. Diseases and Pests of the Oil Palm, by Dr. A. A. L. Rutgers.

The following are the chief diseases and pests of the oil palm which have been observed in the Dutch East Indies.

The crown disease, the cause of which is unknown, is the most important disease in Sumatra. It generally attacks young palms, especially those between one and four years old. In some cases it only affects the leaves of the central spike, but in other cases the youngest leaves surrounding the spike are also involved. The trees invariably recover, and no trace of the disease is visible in later years.

Among beetles, *Oryctes rhinoceros*, *O. trituberculatus*, and *Rhyncophorus ferrugineus* have been observed, but have not hitherto caused any great damage.

The caterpillar of a Pyralid moth, *Melissoblaptes rufovenalis*, has been found damaging the epidermis of the fruits, but without causing any injury to the crop. *Orthocraspeda trima* and *Setora nitens*, caterpillars of the family *Limacodidæ*, have been noticed feeding on the leaves of the oil palm, but neither has become a serious pest. The caterpillar of a Psychid moth, *Lansdownia bifenestralis*, has so far proved the most harmful insect attacking the oil palm in Sumatra ; in some cases several hundred trees have been defoliated by it.

Boring beetles (*Scolytidæ*) have been observed boring the midrib of the oil palm leaf, but apparently without producing any appreciable injury.

Rats, pigs and porcupines sometimes damage the young palms and have occasionally caused the loss of large numbers of the trees.

Chapter VIII. The Preparation of Palm Oil, by Ir. Jhr. F. C. van Heurn.

In this chapter the various methods of preparing palm oil are fully discussed.

In order to obtain a product containing a low percentage of free fatty acids, it is necessary to avoid (1) the use of bunches with loose ripe fruits ; (2) the use of ripe fruits which have fallen to the ground ; (3) bruising the fruits when cutting off the bunches ; (4) bruising the fruits during transportation to the factory and in removing the fruits from the bunches ; (5) removing the pericarp from the fruits before they have been thoroughly heated ; (6) treating the fruits without preliminary sorting ; (7) any cause which prevents the fruits being worked up immediately or necessitates the storage of the fruits and bunches in heaps ; and (8) the burning or browning of the oil by heating the fruits over an open fire.

For the preparation of palm oil, the method employed at first by the European undertakings in Africa was the wet process, as exemplified by Haake's method, but this has now been abandoned in favour of the dry process.

In preparing palm oil by the latter process, the three main steps are heating, depulping or depericarping, and pressing. Various methods of heating the fruits are men-

tioned, and it is stated that experiments have indicated that the best plan is to heat the whole bunches, as this has the advantage that, after heating, the fruits can be easily removed and the question of bruising is of less importance. Two pressings are necessary, the first under low pressure and the second under high pressure. After the first pressing the fruits are depulped and the pulp is dried. The dry material can then be subjected to high pressure without expressing any of the cell contents with the oil.

Chapter IX. Threshing Machines for Oil Palm Fruits, by Ir. H. N. Blommendaal.

Experiments are recorded which were carried out with the object of testing a machine, constructed by the firm of Reinartz, of Neuss, for stripping the fruits from the bunches. It has been found that good results can be obtained with this machine if the bunches are previously heated.

The method presents the following advantages: (1) It diminishes the cost of preparation below that of other methods used in the production of edible palm oil; (2) manual labour is reduced to a minimum; (3) sorting can be dispensed with; (4) the bunches can be worked immediately, so that storing in sheds is unnecessary; (5) the fruits are brought in from the plantation while still on the bunches, and crushing and bruising are thus more easily prevented; (6) the formation of free fatty acids after the bunches arrive at the factory is avoided; and (7) the oil obtained is of an edible character. On the other hand, the method has the disadvantages that (1) the weight to be transported is twice as great in the case of the bunches as in that of the fruit, and (2) plant is necessary for heating the bunches.

Chapter X. Packing, Shipping and Selling of Palm Oil, by Dr. A. A. L. Rutgers.

In this chapter information is given regarding the markets for palm oil and the methods of packing it for shipment. Extracts are given from the *Official Contracts for Palm Oil*, issued by the Liverpool United General Produce Association, regarding the classification of palm oils and the allowances to be made by sellers for impurities

and excess of free fatty acids. It is pointed out that these contracts are evidently not intended for the marketing of palm oil with a very low percentage of free fatty acids (say under 8 per cent.) to be used for edible purposes, as the official contract in general use in Liverpool in January, 1922, allows only an increase of 0·1 per cent. of the price (or 1s. 9d. per ton) for each 1 per cent. of free fatty acids under 18 per cent. It is considered necessary therefore that a new class should be made for edible palm oil, with a special premium for each 1 per cent. reduction in the free fatty acids, and it is stated that manufacturers of edible fats are willing to pay a much higher price for palm oil with a very low percentage of free fatty acids than for ordinary palm oil, provided that sufficient quantities of uniform quality can be regularly supplied.

A description is given of the standard palm oil cask. The casks employed in the African trade are usually returned to Africa and used again and again. As the Sumatra palm oil is more liquid than the African, the rate of leakage from casks that have been used several times is greater in the former case. It is suggested that in the future it may perhaps be possible to ship the Sumatra product in tank steamers, but meanwhile the standard casks must continue to be employed. Some authors have advocated the hardening of the oil before shipment, but this would involve a considerable increase in the cost of preparation. Better results might possibly be obtained by bleaching the oil, which converts it into a homogeneous white solid fat without any liquid fractions.

Bleached palm oil has already been shipped by one of the Belgian undertakings in Sumatra, and the difficulties due to leakage have thereby been much reduced. It seems not unlikely that in the future bleaching will be generally practised on the oil palm estates. The Experiment Station proposes to investigate the comparative value of the bleaching apparatus for palm oil now offered by machinery manufacturers.

Chapter XI. Crop Records of Oil Palms, by Dr. A. A. L. Rutgers.

In previous publications of the A.V R.O.S., the yields

have been recorded of several series of oil palms on the east coast of Sumatra (cf. this BULLETIN, 1920, 18, 245). Additional data are now quoted relating solely to trees of the ordinary Deli type, which are divided into two groups: (1) plantation trees, and (2) ornamental trees, planted along roads and avenues. The latter, as a rule, had been grown under bad conditions; in some cases they were only 12 to 15 ft. apart; in other cases they had been planted too near to teak or Ficus trees; whilst in many cases they had been entirely neglected in past years.

The observations were made on the same lines as in the earlier work, and statistics are given of (1) the gross yield of bunches and of fruits per tree per annum, (2) the percentage of pulp, nuts and kernels in the fruits, and (3) the percentage of oil in the pulp and kernels.

The following are the average numbers of bunches and the average weight of fruits yielded per tree per annum by trees of different ages:

Age	Average number of bunches.	Average weight of fruits. lb.
4th year	—	42
5th year	12·5	99
6th year	11·3	97
7th year	11·2	88
8th year	11·6	99
10 to 15 years	6·9	209
20 to 22 years	7·5	132
30 to 34 years	4·7	75
38 to 41 years (at Buitenzorg)	2·5	60

The high yields of the trees of the age of 10 to 15 years were obtained in the first year after the trees had been cleaned, and during six months of that year artificial pollination was practised. These yields therefore cannot be regarded as normal, and in future years the crops from these trees will probably be smaller.

The crop of fruits in Sumatra is not evenly distributed over the different months of the year, but shows a distinct periodicity, which is induced by the periodicity of the rainfall. The maximum crop is obtained in the dry season, and the minimum in the wet season. The months in which the largest number of bunches ripen are also those in which the weight per bunch is greatest. It

appears that a high annual rainfall evenly distributed through the year gives the best results. The maximum production per month is nearly twice as great as the average monthly production, and it therefore follows that the factory equipment must be sufficient to work at least double the average daily output of the estate.

Data collected during 1918 and 1919 regarding the percentage of pulp, nuts and kernels in the fruits confirm the previous conclusion (this BULLETIN, 1920, **18**, 247) that the palm fruits produced on the east coast of Sumatra contain, on the average, 60 per cent. of pulp and 8 per cent. of kernels. The percentages are practically the same for young and old trees.

Determinations of the percentage of oil in the pulp and in the kernels have shown that, although the amount varies in fruits from individual trees of the same variety, and even in fruits from the same tree, the average quantity may be safely taken as 50 per cent. in the pulp and 50 per cent. in the kernels.

It is calculated that a young oil palm plantation on the east coast of Sumatra will yield 1,350 kilos. of palm oil and 450 kilos. of kernels per hectare in its fifth year (1,200 and 400 lb. respectively per acre), and that the yield will increase to 2,000 kilos. of palm oil and 600 kilos. of kernels when the trees are in full bearing, *i.e.* from the tenth to the thirtieth year (1,750 and 535 lb. per acre).

Assuming a price of £40 per ton for palm oil and £25 per ton for kernels, the return per hectare in the fifth year will be £54 for palm oil and £11 for kernels, whilst when the plantation is in full bearing the annual return will be £80 for palm oil and £16 for kernels, or a total of £96 per hectare (£39 per acre).

The publication contains a full bibliography of oil palm cultivation and five appendixes, viz: (1) The area in both hectares and acres, devoted to the oil palm, on the various estates on the east coast of Sumatra on January 1, 1922, and the total area on January 1 of each of the years 1915, 1916, 1918, 1920 and 1922. (2) The yields, during each of the four years, 1918–21, of 139 oil palms on Marihat Baris, planted as ornamental trees

in 1913. (3) The yields of twenty-nine oil palms on Medan Estate, ten to fifteen years old, and partly artificially pollinated. (4) The world's production of palm oil and palm kernels in tons for each year of the period 1896–1920. (5) The market prices of palm oil and palm kernels in £ sterling per ton for each of the years 1906–1920 inclusive.

The Imperial Institute has recently received a memorandum from Professor Dr. A. H. Berkhout, of the Government Agricultural and Forestry School, Wageningen, Holland, on the subject of oil palm cultivation in the Dutch East Indies. Dr. Berkhout visited Sumatra in 1921, and made a careful study of the plantation industry. Much of the information which he furnishes has already been given above and in the article previously published in this BULLETIN (1920, **18**, 209), but the following observations are of interest.

Dr. Berkhout points out that a single female inflorescence may bear from 1,000 to 2,000 flowers, of which only about one-fourth usually become pollinated by natural agencies. The reason that a larger number are not pollinated is that the protecting sheath surrounds the inflorescence so closely that many of the female flowers cannot be reached by the pollen. It is mentioned that on some of the estates in Sumatra the leaves immediately surrounding the inflorescence are cut off so as to facilitate pollination, and that artificial pollination is being applied. It is considered, however, by Dr. Berkhout that artificial pollination is of doubtful advantage, and in this connection he points out that when growing grapes, instead of trying to increase the number of grapes in the bunch, it is usual to remove some of the younger fruits in order to enable the remainder to obtain sufficient nourishment to grow to a large and attractive size.

Dr. Berkhout refers to the method recommended by the A.V.R.O.S. of sending the whole bunches to the factories (see p. 490), but he considers that, although an edible palm oil can be obtained by this method, the cost of transport will be too high for it to be remunerative,

especially if a tramway is constructed for the purpose. He states, in fact, that a tramway cannot be profitable unless large quantities of bunches are to be transported, and its construction can only be justified where the annual production per unit area is sufficiently important. It is pointed out that in general the harvesting of the oil palm fruits and their transport to the factories are attended with great difficulties, and the opinion is expressed that, if this work is carried out by cheap methods, an oil with a high percentage of free fatty acids is obtained, whilst, if it is done by the methods recommended by the A.V.R.O.S., the expenses are too high for the industry to be profitable.

Dr. Berkhout also remarks that it is very difficult to obtain definite information regarding the net revenue to be derived from an oil palm estate, and he is of opinion that the working expenses of the industry as at present carried on in Sumatra are too high to permit of a good profit being assured. In general, the impression received during his visit to the island was that the selling price of palm oil in Europe was not at that time sufficient to cover the cost of production, and that it was therefore inadvisable to establish new oil palm plantations in the Dutch East Indies. He considers, however, that the existing undertakings will be able gradually to reduce working expenses as the result of experience and the introduction of improved machinery, and may in the future be well repaid for their earlier endeavours.

NOTES

Molybdenum Ores: Imperial Institute Monograph.—A monograph on molybdenum ores in the series of monographs on mineral resources of the Empire, issued under the direction of the Mineral Resources Committee of the Imperial Institute, has been prepared by R. H. Rastall, Sc.D., M.Inst.M.M., F.G.S., Lecturer on Economic Geology in the University of Cambridge, and published by Mr. John Murray.

The book, of eighty-six pages, is divided into three chapters, the first of which includes brief descriptions

of the chief molybdenum minerals, their genesis, concentration and metallurgical treatment, and the properties, uses, prices and world's production of the metal.

The second chapter deals with the sources of supply of molybdenum ores in the British Empire, with descriptions of the more important deposits in Renfrew County, Ontario; Pontiac County, Quebec; New England and Whipstick districts, New South Wales; and Chillagoe and Stanthorpe districts, Queensland. The minor occurrences in India, South Africa, Canada and Australasia are also briefly described.

The third chapter, devoted to foreign sources of supply, describes the principal molydenum deposits of Norway, Arizona, Colorado and Peru, and gives references to minor occurrences in France, Germany, Spain, Mexico, the United States and South America. A map of the world shows the molybdenum-bearing localities referred to in the text, and the monograph concludes with a list of references to literature of molybdenum.

Nauli "Gum": A New Oleo-Resin from the Solomon Islands.—A report under this heading has been published in this BULLETIN (1921, **19**, 457) dealing with the examination of a soft, yellow oleo-resin derived from a tree occurring in the Solomon Islands. It was shown that the oleo-resin on steam distillation yielded a volatile oil possessing the odour of aniseed and containing 34 per cent. of anethole, whilst the resin left after the removal of the oil would be suitable for varnish making. The botanical source of the tree yielding the oleo-resin was not known at the time the report was published, but the Director of the Institute of Science and Industry, Australia, has since informed the Imperial Institute that specimens of the leaves, fruit and seed of the tree have now been identified as *Canarium commune*, Linn., the ordinary "Java almond tree." This identification is of particular interest, since the related species, *C. luzonicum*, Miq., is the source of the well-known Manila elemi, whilst other species of *Canarium* also yield oleo-resins. In none of these products, however, has anethole been recorded as a constituent of the oil.

Ramie, Rhea, or China Grass.—In an article published some years ago in this BULLETIN (1905, **3**, 55), an account was given of the cultivation, preparation and utilisation of the fibre known as ramie, rhea or China grass, which is derived from the bark of the stems of *Boehmeria nivea*, a plant of the Urticaceæ or nettle family.

At that time, some attention was being given to the possibilities of this crop in India and other parts of the British Empire. Although it was found that the plant would thrive in most of these countries and that the cultivation offered little difficulty, the industry has not made any progress, owing to the fact that ramie spinners will not purchase the fibre unless it is in the form of hand-cleaned China grass. The spinners degum this product by chemical methods which they have developed in their own factories and which would require modification if the fibre were received in any other condition.

The hand-cleaned China grass is prepared in China by a tedious process, which can only be employed when very cheap labour is available. The bark is stripped from the stems and the outer skin is removed by scraping and washing, some of the gummy encrusting matter being extracted during the process. Only a few pounds of the product are obtained as the result of a whole day's work. The gummy matter still remaining in the fibre is removed by the spinner, as already mentioned, in order to obtain the clean, lustrous filasse.

British ramie spinners who have been consulted by the Imperial Institute state that they do not experience any difficulty in obtaining all the ramie they require from China.

It is evident that a product similar in appearance and quality to hand-cleaned China grass could not be profitably produced in any British territory unless the preparation could be effected by machinery. Apparently, however, no machine has yet been placed on the market which is capable of carrying out the work to the satisfaction of the spinner.

In view of these facts, it is obvious that in present circumstances the cultivation of ramie in India and the Colonies cannot be recommended.

The cultivation of ramie in China is carried on chiefly in the valleys of the Provinces of Hunan, Hupeh, Kiangsi and Szechuen. The plant is also grown to some extent in Kwangtung, and is found in all the warmer parts of China up to an elevation of 4,000 ft.

The Chinese customs returns show that the chief points of original export abroad and to other parts of China are Hankow, Kiukiang and Yochow. The greater part of the ramie exported from other parts of China is received in Swatow, the centre of the China grass-cloth industry. Of the exports of this grass-cloth, about 80 per cent. is absorbed by Korea.

The exports of ramie from China during the years 1918–20 are shown in the following table:

Exported to:	1918. Tons.	1919. Tons.	1920. Tons.
Hong Kong	573	283	285
French Indo-China	30	46	83
Siam	5·5	10	13
Singapore, Straits, etc.	4·5	7·5	—
Great Britain	1,291	263·5	1,169
Germany	—	—	10
Netherlands	—	75	120
Belgium	—	32·5	62
France	656	120·5	160
Italy	—	0·5	30
Austria and Hungary	—	1	—
Japan (including Formosa)	12,194	11,693·5	9,199
Philippine Islands	—	1	—
United States (including Hawaii)	1,593	22	2
Total	16,347	12,556	11,133

It is evident from these statistics that approximately 90 per cent. of the total exports are taken by Japan, where the fibre is used for the manufacture of clothing.

The imports of ramie into the United Kingdom in 1920 amounted to 1,760 tons of value £222,018.

The best quality of China grass (Yuenkong) is now quoted in the London market at about £80 per ton, and the Poochi quality at about £65 per ton (December, 1922).

Agricultural Organisation in Queensland.—Effective steps have recently been taken to establish a unified national organisation for the agricultural industries of Queensland, and an Association has been formed, under the presidency of the Minister for Agriculture, the aim of which is to promote co-operation among all classes of agriculturists, such as graziers, fruit and wheat producers, dairymen, sugar growers and general farmers. It has been arranged that the Association, which is known as the Queensland Producers' Association, shall consist of a Council of Agriculture under Government auspices, District Councils, and Local Producers' Associations.

Pending the establishment of a permanent Council of Agriculture, a Provisional Council has been appointed, consisting of twenty-two members, of whom five are directly appointed by the Government and the remainder in certain fixed proportions by the representatives of the dairying, fruit-growing, sugar-growing and general agricultural industries. The objects of the Council are described

as follows: (*a*) To co-operate with and assist District Councils and Local Producers' Associations; (*b*) to engage in research work on subjects relating to the rural industries and to secure effective action for the controlling of diseases and pests; (*c*) to secure additional markets and to improve the transport and distribution of produce; (*d*) to standardise products and assist and advise the Department of Agriculture and other State Departments; and (*e*) generally, to investigate and deal with all problems relating to rural industries.

The District Councils will represent areas determined by the Council of Agriculture and will consist of representatives elected by the Local Producers' Associations. The latter Associations may be formed in constituted districts by bodies of at least fifteen *bona fide* producers, and their duties and functions will be largely in the direction of taking initiatory steps in matters which will be dealt with by the District Councils and the Council of Agriculture.

The Queensland Producers' Association issued in July last its first *Bulletin*, in which the entire scheme is described in detail; and articles on the subject have appeared in recent issues of the *Queensland Agricultural Journal*. The new enterprise is also receiving much publicity in other directions, and when the various councils and local associations are in full working order the effect on the agricultural industries of the country should be very beneficial.

The Utilisation of Palm Oil as a Motor Fuel in the Gold Coast.—An account of experiments conducted on the use of palm oil as a fuel in internal combustion engines has already been given in this BULLETIN (1921, **19**, 379; 1922, **20**, 230). The present note deals with preliminary trials which have been recently conducted in the Gold Coast.

The engine used in the Gold Coast experiments was a 28 h.p. engine made by Messrs. Tangye, of semi-Diesel type, four-cycle, and having one horizontal cylinder. The hot bulb of the engine was heated to the same temperature as was usual when it was used with mineral oil, and then the palm oil, previously warmed to 40° C., was injected into the cylinder. The engine started up without any trouble and was run for two hours. The consumption of palm oil was found to be 1½ gallons per hour. During the running no sign of overheating was noticed, and the exhaust gases showed that perfect combustion was taking place. No load was put upon the engine beyond that of

driving the shafting and belts in the workshop. Considering that the engine used was ten years old, its cylinder liner and piston worn oval, and that the valves required reseating, the results of the trial were satisfactory and showed that excellent results could be obtained from using palm oil as the fuel for internal combustion engines.

Further trials were undertaken to compare the consumption of fuel and the running of this engine when using palm oil and first-grade mineral oil. In these trials the same Tangye engine was employed as in the former case, but alterations had been made to the air valve, the atomiser and the pressure pump, while the valves had been reseated and new piston rings fitted. In spite of these alterations a considerable amount of compression was lost. With palm oil as the fuel, the engine started up from cold, although the oil was not heated prior to its being placed in the supply tank. The palm oil used contained from 5 to 6 per cent. of free fatty acids. After a continuous run of twenty-four hours the engine was dissembled, when it was found that there was no deposit on the cylinder walls and the piston head, but a slight one on the atomiser and the exhaust valve. The consumption of palm oil was 0·24 lb. per B.H.P. per hour, as compared with a consumption of 0·20 lb. for the mineral oil. It was found, however, that with palm oil the amount of cylinder oil necessary was reduced by 75 per cent. It is therefore slightly cheaper to use palm oil than mineral oil in this engine when the respective prices of palm oil and mineral oil are 2*s.* 6*d.* and 2*s.* 8*d.* per gallon. It was noticed that the engine ran far more regularly with palm oil, and the exhaust gases were quite clear, showing that combustion was complete. Palm oil is, for this reason, considered a better fuel. Moreover, when palm oil was being used no injection of water was necessary, but with mineral oil water injection was absolutely essential, for without it the engine overheated and pre-ignition was much in evidence. This difference in behaviour is ascribed to the lower calorific value of the former oil and the presence of water in it.

These experiments carried out in the Gold Coast show that palm oil can be successfully used with internal combustion engines and that it could be employed on a commercial scale provided that the engine was of the right type and the cost of production of palm oil sufficiently low. The engine must be of the Diesel or semi-Diesel type, in which the fuel is injected in the form of a spray. The cost of the palm oil varies with the local conditions and the method used in its production. Unless it can be

produced at a lower cost than mineral oil, its use is not worth considering.

It has been suggested that palm oil might be used in the Gold Coast as a fuel for railway locomotives. At present, however, its use in this way seems unlikely, since the price of palm oil at Seccondee is about £25 per ton and that of coal £3 10s. It has been computed that in order that palm oil may compete with coal for this purpose, its price must not be more than twice that of the latter.

The Manufacture of Fish Oil and Guano in Madras.—An account of the progress of the work initiated by the Madras Government Fisheries Department in 1908–9 is given in a report by Sir F. A. Nicholson, K.C.I.E., late Honorary Director, Government Fisheries, Madras (*Bulletin* No. 13, 1921, *Madras Fisheries*, pp. 147–266).

Prior to 1908 the quantity of fish caught in a season was far in excess of that required for local consumption as fresh fish and for the curing industry, and the surplus was dried, unsalted, on the beach, to be used for fish-manure. This process, besides being extremely offensive, is very wasteful, as considerable loss is entailed through putrefaction and by the ravages of insects during the drying. In addition, the oil is wholly wasted, being changed in the process of drying into a hard agglutinated substance. Another disadvantage is that a large quantity of sand becomes incorporated in the manure through contact with the beach. The manurial value of the product obtained by this method is much reduced, owing to the loss of nitrogen in the form of ammonia, caused by the putrefaction, and to the presence of large amounts of sand, while the agglutinated oil is harmful to the soil.

With a view to removing these defects, experiments were conducted at Cannanore and later at Tanur by the method practised in the United States of America, where the fish are boiled in water and the oil removed from them by expression prior to their being dried for fish-guano (see this BULLETIN, 1914, **12**, 50; 1917, **15**, 113). So successful were these experimental trials, that the use of this method spread rapidly and by 1920–21 there were over 600 small factories along the Malabar and South Kanara coast, while the output of dry fish-guano rose from nil in 1908 to more than 20,000 tons in 1919–20, of which the greater part was exported.

The *Report* shows how the manufacture of fish-oil and guano in Madras may be improved; it deals with the methods already practised in the Madras Presidency,

as well as those employed in the United States. A list of the precautions necessary to produce an oil of good quality is given, whilst attention is also drawn to the proper disposal and utilisation of effluent water, to the advantages that would result from the co-operation of the manufacturers, and to the necessity for by-laws covering the manufacture of guano. Reference is also made to the question of prohibiting the export of fish-guano, with a view to improving the fertility of Indian soils.

The fish used in the Madras industry is the "oil-sardine" (*Clupea longiceps*), which appears off the west coast of the Presidency in numerous shoals between August and the following June. The yield of oil varies from year to year according to the size and age of the fish; those that are fat and adult often give from 10 to 15 per cent., whilst in the young and lean the percentage is small. The fish are caught by enclosing the shoal in a net, similar to the American purse net, though in the northern parts of South Kanara a fine seine net is gradually being introduced. The 600 factories in existence are distributed along the coast between Cochin and Kundapur, a distance of about 250 miles, but by far the larger number are in South Kanara. They are all built close to the sea, or to backwaters communicating with it, but many are very unsuitable and have very limited facilities for carrying out the process on hygienic lines.

The plant employed is of the simplest description, and usually consists of one or two iron boiling pans, set in masonry over open fires and capable of holding about a ton of fish; from two to four hand-presses; two separating pits; and a tank for the storage of the oil. The drying ground for the guano should take the form of a "barbecue," or platform of concrete or hard earth, sufficiently large to accommodate the output of two or three days, but a good deal of the guano is at present dried on the sand. The store for the guano completes the necessary plant. In the Government Yard at Tanur the arrangements, though still simple, are more advanced, and include steam-heated pans, and buildings built on more sanitary principles.

The method, as originally practised in 1908, consisted of boiling the fish over an open fire, pressing the mass in a wooden press, separating the oil and the water in a collecting pit, reheating the oil to sterilise it and then putting it into barrels. The fish-guano was sun-dried on mats on the sand. The present-day method is

similar, although the boiling pans are larger, the presses are made of iron and the drying of the guano is generally done on barbecues. The disadvantages of this method are numerous. In the first place the pans are too large to ensure the thorough heating of the mass of fish. Unless the mass is well stirred during the heating, the oil is liable to become burnt, the scorching being assisted by the smallness of the amount of water which is added. The reboiling of the oil, for the purpose of sterilising it, is often defective and further scorching takes place. The separation of the organic matter and the water from the oil is liable to be incomplete, whereby the odour is rendered unpleasant and the acidity is greatly increased. The lack of proper drying grounds (barbecues) is another source of loss to the manufacturers through the admixture of sand with the guano. The fish are frequently tainted before they are boiled, because the plant is not large enough to deal with the capture sufficiently rapidly. The effluent water is not drained away properly, with the result that it lies about the works in pools and gives off offensive odours.

At the Government Yard at Tanur all these defects are avoided, with the exception of the last, the satisfactory disposal of the effluent water not yet having been accomplished, owing to the distance from the sea. The boiling is carried out with steam in a vertical boiler, in which the water and the fish are brought to the proper temperature in about half an hour. Plenty of water is used in this operation, and the oil that is liberated in the heating is skimmed off and kept separate from the inferior oil obtained in the later stages of manufacture. The mass of fish and water from the boiling pan is transferred to a draining trough, fitted with a false bottom, whereby the mass is readily freed from much of the water. Any oil that drains away with the water is added to that obtained from the presses. The well-drained mass is then placed in coarse coir bags and introduced into the press, when a mixture of oil and water passes away into a settling pit, where the oil is separated from the water. The press cakes are carried to the drying grounds, where they are broken up and spread out to dry in the sun. The separated oil is thoroughly washed once or twice with hot water, salt water preferably, and then separated from the washings. The washed oil may be sterilised by heating it at a temperature slightly above 212° F. by means of steam, but this process has not been found necessary at Tanur, as the oil has not been produced in large quantities and is always so well washed that it keeps satisfactorily.

The yield of guano from the fresh fish is about 20 per cent. on the west coast of Madras, as compared with about 22 per cent. in the United States. Samples of fish-guano, prepared at the Government Fisheries Station, South Malabar, and at the Government Experiment Station at Tanur, have been examined at the Imperial Institute and found to be of normal composition (see this BULLETIN, 1914, **12**, 50).

Although there was only a small supply of guano available in 1920–21, the prices realised by the exports in that year were much below the normal on account of the poor demand. The small demand is stated to have been due to the gross adulteration with sand in previous years, especially in 1919–20, when in some cases European firms refused to take delivery of consignments for this reason. As a result of the low prices some factory owners reverted to the old method of drying the whole fish on the beach. The new guano manufacturing industry thus received a set-back.

Samples of fish oil prepared under the auspices of the Madras Fisheries Department have been examined at the Imperial Institute, and found to be suitable for the usual purposes to which fish oils are applied, viz. leather dressing and currying, and the manufacture of soft soap, paint oils, etc. (see this BULLETIN, 1914, **12**, 50).

As regards the disposal of the effluent water, it is suggested that, as it has a certain manurial value, it might be profitably used for the purpose of irrigating fruit trees, coconut palms and field crops. Other methods for disposing of the effluent water consist of treating it with lime or by the use of septic tanks.

The precautions which should be taken in the manufacture of fish-oil include the following. The oil should be prepared from fresh fish, free from taint, and, if delay is likely to occur, the fish should be freely salted. The oil should be rapidly separated from the fish mass and also from the water; it should be well washed with boiling water, after which all traces of moisture should be removed and the oil stored under proper conditions.

The methods of refining comprise purification by suitable sedimentation, clarification with fullers' earth and subsequent filtration, dehydration by heating with steam, neutralisation of the acidity by alkali, deodorisation by passing live steam through the oil and, if necessary, decolorisation.

The Diamond Industry of India.—An illustrated article on the diamond industry of India, by Mr. Cyril S. Fox, of the

Geological Survey of India, has appeared in a recent number of the *Diamond Worker* (Nov. 1922, p. 4). The following notes are taken mainly from this article, but to some extent from other sources of information.

Diamonds have been associated with India from the dawn of history, and until 1725, when they were discovered in Brazil, India was the only diamond-producing country in the world. Before 1600, the Indian lapidaries had learnt to cleave diamonds and to polish them with diamond powder. About the sixteenth and seventeenth centuries some remarkable diamonds were obtained from India, *e.g.* the Great Mogul (787·5 carats in the rough), Koh-i-noor (recut, 106·6 carats), the Orloff (194·75 carats), and the Pitt or Regent (cut, 164 carats). The Koh-i-noor and Orloff diamonds are believed to be fragments of the Great Mogul.

The diamond localities in India are classified into three groups, all belonging to rocks believed to be of pre-Cambrian age. The southern group includes the districts of Cuddapah, Anantapur, Bellary, Karnul, Kistna and Godavari. In this group the diamonds occur on the surface, in deposits of alluvium, and in a shaly conglomerate or breccia in the Banganapalle sandstone, lying at the base of quartzite in the Karnul series of Madras. This horizon corresponds to the Semri sandstone of the lower Vindhyan formation of Northern India. In the second or eastern group of the Mahanadi Valley, the stones occur in alluvium. The third or central group occupies an area, sixty miles long by ten miles wide, near Panna as the centre, belonging to the Rewa group of the upper Vindhyan formation, which is absent in Madras. The diamond-mining industry still persists in this area, the gems occurring in a conglomerate or in alluvium derived therefrom. The States in which diamonds are found are Panna, Charkhari, Bijawar, Ajaigarh, Kothi, Pathar, Kachlar, Baraunda and Chobepur.

According to E. Vredenburg (*Rec. Geol. Survey, India*, 1906, **33**, 275), the diamonds occur in a compact conglomerate containing vein-quartz, pebbles of jasper (*sili*), green vitreous quartzite (*kansya*), etc., in an arenaceous ground-mass, which lies at the base of the Rewa shale and rests on the Kaimur sandstone. The local name for the diamantiferous conglomerate with sandstone matrix is *mudda*. When weathered or friable with a shaly matrix, it is known as *kakru*. There is a second diamantiferous conglomerate higher in the series, or at the base of the Bhanda shales and at the top of the Rewa sandstone, but it does not appear to have been found *in situ*. The

conglomerate was formerly mined by sinking great pits, some 25 ft. in diameter and from 30 to 50 ft. in depth, called "direct" workings by Vredenburg, to distinguish them from the shallow and alluvial workings. The diamantiferous material was hoisted in baskets to the surface and the workings were drained by means of Persian bucket-wheels worked by bullocks, or by hand (V. Ball, *Manual of the Geology of India, Part 3, Economic Geology*, 1881, p. 49).

During the last decade the production of diamonds from Indian mines has not averaged 100 carats a year. In those areas where from time to time occasional stones are still discovered, the villagers search the most likely places—fields, talus slopes, stream beds, etc.—after heavy rains or floods. The ground has been so thoroughly searched that new occurrences of the gem are now seldom found.

Mr. Fox, in his article, refers to the ingenious devices employed in the mechanical treatment of ores, and to the well-known fact that diamonds and other precious stones adhere in a greater or less degree to grease, while quartz, sand and other valueless minerals adhere so weakly that they are easily washed off such a surface, and he points out that in the Union of South Africa "grease tables" and "grease belts" probably find 90 per cent. of the diamonds produced. He therefore suggests the scientific prospecting for Indian diamonds with suitable grease appliances. The dark basic rock in the Madras diamond area of Wagra Karur would probably be the most attractive for experimental treatment, although the diamond-bearing gravels of Panna State, and the sands of any river in which gemstones have been found would answer equally for such an experiment. It is impossible to say whether the operation would be profitable, but it is certain that more stones would be found than by the existing methods of search.

Although a large number of Indian stones in the rough find their way to Europe, a cutting and polishing industry for precious stones has existed in a small way at Delhi, Jubbalpore, Ratanpur and various other places in India, but the workmanship is not of such a high order as that of Europe.

Petroleum in Mesopotamia.—A general account of petroleum occurrences in Mesopotamia has been given in the *Imperial Institute Monograph on Petroleum*, 1921, p. 23. Further information is afforded in fourteen reports, together with a summary report, on the petroliferous

areas of Mesopotamia, by E. H. Pascoe, the Director of the Geological Survey of India, which have been published recently (" Geological Notes on Mesopotamia, with Special Reference to Occurrences of Petroleum," *Mem. Geol. Survey, India*, 1922, **48**).

The geological reconnaissance described in these reports was made in 1918–19. Two Tertiary series only were encountered, the older forming part of Pilgrim's marine Fars series, of Persia, whilst the younger fluviatile series has been called provisionally the Kurd series by Pascoe, until it becomes known more precisely to what extent it corresponds to Pilgrim's Bakhtiyari series of Persia.

Among the areas considered by Pascoe to be of first-class importance (A) are Qaiyarah (Report 4) and Quwair (Report 8). The former or Jabal Qaiyarah extends in a general west-north-west direction from the right bank of the Tigris at Qaiyarah military post, which is thirty-five miles south of Mosul and twenty-two and a half miles north of Shargat. The structure is that of a simple anticline, exposing Fars beds, consisting of gypsum, greenish and red clays and thin bands of limestone, flanked by the red clays and sandstones of the Kurd series. Four areas where seepages occur were located by Pascoe, of which the two principal consist of patches of bitumen and tarry oil. Seven borings were made by the Germans before the recent British occupation, of which four are producing, or capable of producing, and three are " dry." Test wells are recommended in the two areas Qaiyarah and Qishlah, as the structure, seepages, etc., favour the view that an oil-field of importance exists here. As the wells of the former area are too far down the pitch to give maximum yields, other locations are suggested.

Quwair is a gendarmerie post on the left bank of the Greater Zab, about eight miles from the confluence of this river with the Tigris. Beds of the usual kind of both Fars and Kurd series occur here. The structure is a dome, and seepages of black tarry oil are found in several places along the river bank. In Pascoe's opinion, the chances of this being a field of considerable value are distinctly good, and he points out the best location for a test well.

Areas less certain, but of decided promise (B), are Jabal Hamrin and Makhul, near the Tigris (Report 2). The former is a long, narrow range projecting from the alluvial plain, and extending from Fathah on the Tigris south-eastwards for over 100 miles to the latitude of Shahraban, and across the river north-westwards for another thirty-seven miles under the name of Jabal

Makhul. The rocks comprise a central core of gypsiferous beds belonging to the Fars, and flanked on either side by the Kurd series. In both banks of the river, and in some of the small water-courses around Fathah, limestones of the former series are found seeping tarry oil and bitumen. Both gypsum and gypsum clay in the neighbourhood of the oil seepages contain yellow sulphur, and emit a strong odour of hydrogen sulphide. The above ranges coincide with a remarkably long and persistent simple anticline. Northwards, from three and a quarter to five and a quarter miles distant, there is another, not quite parallel, anticline. The Hamrin-Makhul anticline is slightly asymmetric. Three separate oil horizons of seeping cellular limestone can be distinctly traced for some distance, passing from one side of the river to the other. The best positions for two test wells are indicated.

The similarity in conditions between Mesopotamia and the oil regions of India and Burma are worth pointing out. There is a petroliferous series containing saline products and marine fossils, indicative of a desiccated gulf, followed by a fluviatile deposit, the river having in all probability replaced the gulf, just as in the Punjab, Assam and Burma. The folds became steeper towards the eastern margin of the gulf, *i.e.* the quarter from which the folding movement proceeded.

The remaining areas are classified as follows in the report: (C) areas of uncertain prospects, but sufficiently promising to warrant a test boring, viz. Jebal Mishrak (Report 5); Hawi Arslan (Report 6); and Kirku (Report 3); (D) areas whose prospects depend more or less on the success or failure of certain neighbouring areas; (E) areas of speculative location; and (F) purely speculative areas.

The report is well illustrated with geological maps and sections. In Pascoe's opinion Mesopotamia "will probably take a not unimportant place among the world's sources of petroleum. It should rival the Persian fields and collectively outclass those of Burma."

RECENT PROGRESS IN AGRICULTURE AND THE DEVELOPMENT OF NATURAL RESOURCES

In this section of the BULLETIN *a summary is given of the contents of the more important papers and reports received during the preceding quarter, in so far as these relate to tropical agriculture and the utilisation of the natural resources of the Colonies, India and the Tropics generally. It must be understood that the Imperial Institute accepts no responsibility for the opinions expressed in the papers and reports summarised.*

AGRICULTURE

FOODSTUFFS

Sugar.—According to the *Ann. Rep., Dept. Agric., Colony and Protectorate of Kenya for the year ended March* 31, 1921, the interest taken in sugar-cane cultivation in Kenya has recently developed to such an extent that the foundations of a large and prosperous industry have been established. The Colony possesses large, fertile areas, admirably adapted to the crop and possessing good transport facilities. The best of these are Tanaland, Sabaki and Vanga, which are provided with water transport and also have the advantage of the railway crossing the Tsavo plains.

An area of 6,000 acres near Kibos has been set apart for sugar-cane growing, and a mill is to be erected of sufficient capacity to meet the total needs of the Colony and neighbouring territories in respect of "crystallised" sugar. Throughout the whole stretch of country from Kibos to Fort Ternan signs of activity are everywhere evident.

Numerous enquiries from all parts of the Colony have been received by the Department of Agriculture with regard to sugar cultivation, and more orders have been received for seed canes than could be satisfied. A printed leaflet on sugar growing has been issued by the Department for distribution.

The variety of cane which has hitherto been planted in the Colony is the "Uba" cane. This, however, is more difficult to crush than the soft, thick canes, and gives a lower yield. The latter varieties are superior to the "Uba" cane for the manufacture of "jaggery," and should be grown wherever the conditions are suitable.

Coconut Jaggery.—A paper on "The Improvement of the Coconut Jaggery Industry on the West Coast" has been contributed to the *Agric. Journ. of India* (1922, **17**, 353) by Roland V. Norris, D.Sc., Government Agricultural

Chemist, Madras, in collaboration with the Assistant Chemists, B. Visvanath and K. Govindan Nair, B.A.

In the Malabar District of the West Coast of India an unrefined sugar or "jaggery" is manufactured for local consumption from the fresh juice of the coconut palm. The juice is obtained by tapping the inflorescence. The spadix before it reaches maturity is firmly bound round to prevent it from bursting at a later stage. The pointed tip of the spadix is then cut off, and the sides of the spadix are well bruised, thus effecting the rupture of many of the cells and stimulating the secretion of the juice. The yield of juice is largely dependent on the thoroughness with which this bruising is carried out. A thin section is cut daily from the end of the spadix and the bruising repeated. The juice begins to flow after this treatment has been continued for a fortnight and is maintained until the spadix becomes too short for further operations, the total period of flow being about six weeks on the average.

The juice is collected either once or twice a day in mud pots, coated internally with slaked lime. The contents of the pots, after being strained to remove insects and other extraneous matter, are concentrated by boiling in mud pots and stirred vigorously with a wooden pestle until crystallisation commences. The syrup is then poured into moulds made either of shells or of strips of coconut palm leaf, and allowed to set. The jaggery so produced is of dark colour and contains much foreign matter. It does not keep well, and on storage quickly passes into the form of molasses.

The fresh coconut palm juice is clear and colourless and contains about 15 per cent. of sucrose and 1 per cent. of glucose. The jaggery, however, is usually much darker than that prepared from the sugar cane, has inferior keeping qualities, and is therefore sold at a lower price than cane jaggery. If it were more carefully prepared and the quality thereby improved, the commercial value would be increased. Attention is particularly needed with regard to cleanliness, colour, and keeping quality.

It has been experimentally demonstrated that a cleaner product could be obtained by the use of a sand filter, a simple form of which is described. The dark colour is due to the presence of an excess of lime in the juice and to over-heating during concentration. The mud pots employed for boiling the juice might advantageously be replaced by copper or iron pans. In order to remove the excess of lime before boiling the juice, a small quantity of alum may be added, and after the precipitate has subsided the clear liquid may be decanted. This treatment enables

a hard, white product of excellent appearance and good keeping qualities to be obtained.

The tapping of the coconut palm for the preparation of jaggery causes a reduction in the yield of coconuts, and it is therefore of importance to ascertain the exact returns obtainable in jaggery manufacture. A study is being made of this question at the Coconut Experiment Station at Kasaragod, and the results will be published later. Meanwhile it can be stated that when the worker makes the jaggery in his spare time, as is usual in Malabar, and wages for tapping are thus excluded, jaggery manufacture is more profitable than the production and sale of coconuts.

Oils and Oil Seeds

Palm Oil.—Reference has been made in this Bulletin (1922, **20**, 229) to steps which are being taken to improve the exploitation and cultivation of the oil palm in the Ivory Coast. It is now stated (*Bull. Matières Grasses*, 1922, Nos. 1 and 2, p. 19) that the site for an experiment station has been chosen at a place near the mouth of the River Mé and a few miles from the Agricultural Station at Bingerville. It has been recommended that another station should be started in Dahomey at Pobé close to Porto-Novo. The work to be undertaken in the Ivory Coast includes the supervision by experts from the station of the management of palm plantations by their owners, the introduction of machinery for the treatment of the fruits, the prospecting of the forest with a view to the formation of plantations under European control and the systematic exploitation of forests hitherto untouched.

A similar programme has been drawn up for the station in Dahomey, which also includes the treatment of the fruits on an industrial scale and the popularisation of the variety of the oil-palm selected as the most profitable to cultivate.

The work of selection in the Ivory Coast will be carried out in two stages. The first stage will take twelve years to complete and will consist in the selection of the most suitable type of palm from among those already found in the district, while the second stage will not commence until after the completion of the first and will be conducted on the most promising types discovered in the earlier stage. In order to prevent hybridisation, the palms in the experimental plantations will be surrounded with a dense screen of trees. Cocoa and coffee are to be planted between the rows of palms. The total outlay on the work to be undertaken at the station in the Ivory Coast is estimated

at about 4½ million francs spread over seven years, at the expiry of which the receipts should exceed the annual expenditure. From the fourteenth year onwards the profit anticipated is 151,000 francs yearly.

The total expenditure necessary for the station at Pobé in Dahomey is less than that for the station in the Ivory Coast, viz. about three million francs. The receipts should begin to exceed the expenses in the seventh year as in the former case and at the end of the fourteenth year the profits should amount to 246,000 francs per annum.

Ground Nuts.—Trials are to be undertaken at the Experiment Station at M'Bambey, Senegal, with the object of increasing the production of ground nuts in that country. The work is divided into two sections: the selection of the most suitable seed, and the cultivation of the seed selected (*Bull. Matières Grasses*, 1922, Nos. 1 and 2, p. 9). The various types of ground nuts grown at present in Senegal are to be studied, pure types are to be isolated from them and the selection of the most suitable will then be made. The seed thus selected will be grown at various places in order to ascertain the yields on different soils, and experiments will be conducted with a view to finding the method of cultivation most suitable for the variety. Further experiments will be carried out to indicate the influence of manures and forest vegetation. A study is to be made of the diseases and pests of the plant.

Trials already made have shown that the ground nut is sensitive to selection and a period of from four to five years is considered to be sufficiently long to conclude the experiments on the selection of the most suitable seed. At the end of that time large scale trials will be undertaken when, it is hoped, there will be sufficient seed available for distribution to the natives.

Among the methods of cultivation to be investigated are those in which machines drawn by tractors and also by animals are employed, for which purpose it will be necessary to purchase 30 horses. The livestock already existing at the Station is to be increased to 100 head of cattle and 120 pigs which will provide the manure required for the manurial experiments.

The cost of carrying out these experiments is estimated at about four and a half million francs, including a million francs for wages, and this expenditure is to be spread over a period of five years.

Irvingia spp.—The characters and possible uses of the fats derived from the seeds of two species of *Irvingia* are

recorded in the *Bull. Agric. Congo Belge* (1922, **13**, 68). *I. gabonensis* (*I. Barteri*), from the nuts of which "Dika" butter is prepared, is found throughout West Africa (cf. this BULLETIN, 1906, **4**, 19; and 1908, **6**, 374, in which reports on Dika kernels and butter from Nigeria, examined at the Imperial Institute, will be found). The fruit is a green drupe the size of an apple and about 2 to 2·5 in. in diameter. It consists of a fleshy mesocarp, with an odour strongly resembling turpentine, covering an elongated flat nut, irregularly oval in shape. The horny shell of the nut encloses a kernel about the size of a pigeon's egg. The interior of the kernel has a starchy appearance and is covered with a thin shiny coat. The kernel has a pleasant taste with a slightly bitter after-taste. The nuts consist of 80 per cent. of shell and 20 per cent. of kernels. The kernels contain from 54 to 67 per cent. of fat and are used for the preparation of Dika butter, which is obtained by grinding them in a mortar with water and then pressing the mass hot. The results recorded of the analysis of two samples of this butter prepared in the Belgian Congo are similar to those obtained at the Imperial Institute. It is suggested that this fat might be employed with advantage for the manufacture of soap and in pharmaceutical preparations as well as in the manufacture of butter and cocoa butter substitutes. The cake might be used as a foodstuff and a feeding stuff similarly to that of copra.

I. Oliveri, the other species described, is found in Cambodia, Cochin-China and Annam. The fruit is ovoid or ellipsoidal in shape and the size of a plum. The mesocarp is fibrous and the nut resembles an almond in size and shape and is smaller than that of *I. gabonensis*. The shell is very hard. The percentage of kernel in the nut is about the same as in the case of Dika nut. The kernels contain from 52 to 74 per cent. of oil.

It is recommended that samples of these fats should be sent for trial to manufacturers of chocolates, margarine and soap. In the event of the trials proving satisfactory, arrangements should be made to ensure the production of sufficient quantities of the butters. It is not considered profitable to export the nuts owing to the high proportion of shell.

Whale Oil.—The whaling industry of Natal is suffering from the prevalent financial depression. The price of whale oil has fallen to a remarkable extent during the past year. In 1920 the oil realised as much as £90 per ton, while in 1921 the price fell to about £31 per ton. In the latter year there was little demand for the oil in Europe, although

a demand continued in the United States of America. It is stated in the *Oil, Paint and Drug Reporter* (August 14, 1922, p. 35) that unless the cost of production of whale oil can be substantially reduced few of the local companies will resume operations this year. In 1921 there were three companies engaged in the industry, which employed 17 whalers and between them caught 1,071 whales. This number of whales was greater than that of the preceding year in spite of exceptionally stormy weather. The output for 1921 consisted of 6,255 tons of whale oil, valued at £155,000; 2,447 tons of fertiliser valued at £25,000; and 1,045 tons of boiled bones, valued at £8,000.

Although the seas south and east of Patagonia abound in whales, very little attention is given to their capture (*Journ. Roy. Soc. Arts*, 1922, **70**, 630). There is only one Argentine company engaged in this industry, with a station in South Georgia Island and employing four whalers and one sailing vessel, which transports the whale oil and fertiliser to the United Kingdom. The size of the fleet, however, is being increased.

Whales in their migration from the Antarctic Ocean to the north pass this island in the month of November and again in February and March on their return south. The whalers are sent out daily and bring back their captured whales to land. The company operates an extracting plant and a crushing mill on the island. The annual production varies from 25,000 to 30,000 barrels of whale oil, while, in addition, 5,000 barrels of seal oil are produced. From 8,000 to 10,000 barrels of whale oil are sent to the Argentine and the remainder is exported direct to England. Five grades of whale oil and two of seal oil are manufactured. Recently the production of fertiliser has commenced and it is estimated that 3,000 tons of ground fertiliser will be prepared annually.

Rubber

Hevea brasiliensis

Cultivation.—The *Archief voor de Rubbercultuur in Ned.-Indië* (July 6, 1922, p. 250) contains a paper by J. G. J. A. Maas in which the influence of tilling the soil of rubber plantations is discussed and the advantages of green manuring over clean weeding are pointed out. As the result of cultivation experiments with 12 four-acre plots it is concluded that tilling does not have a beneficial effect.

In the same journal is an account of experiments by Dr. Rutgers in which a similar conclusion is reached.

Dr. de Vries (*Arch. v. de Rubb. Ned.-Indië*, Aug. 6, 1922, 295) records the quality and yield of the rubber from a field which had remained unweeded for 12 months and compares the results with those obtained from the same land after weeding had commenced, and from a neighbouring well-weeded piece of land.

The differences obtained were small and did not indicate a real improvement in the rubber by cleaning up the undergrowth.

As a result of the low price of rubber, few estates in Malaya have been able to afford the heavy item of expenditure involved in clean weeding. An article by L. V. Berenger in *The Planter* (July, 1922, p. 214) shows that clean weeding is not only unnecessary but is also responsible for the rapid deterioration of the once virgin soil of Malaya. It is well known that the top soil is the most valuable for agricultural purposes, and clean weeding with the necessary frequent changkolling (hoeing) results in a rapid leaching of the surface soil. As a result of experiments carried out on a large scale in Java, Sumatra, Ceylon and recently in Malaya, it has been proved that weeds can be kept down and the loss of top soil avoided by the growth of judicious cover crops which, once established, cost little and enable the planter to become more independent of both labour and capital during the maturing of the rubber trees.

In temperate countries it is the practice to allow land to remain fallow to improve the tilth, but in the tropics the heavy rainfall combined with the burning sun makes this rather disappointing. Therefore agriculturists have investigated the possible benefits that might be obtained from cover crops, preferably leguminous. The chief advantages found are: (1) The ground is covered in short time with a thick mulch of green dressing, which not only retains moisture and prevents wash, but in time adds a considerable quantity of humus to the soil. (2) The soluble organic products of decomposition soon leach into the ground and increase the solubility of various inorganic salts. (3) Caking of the surface soil is prevented. Caking is caused by the beating action of heavy rains, and results in time in the formation of a hard crust detrimental to bacterial life. (4) Erosion of the soil is prevented. (5) By pushing their roots into the lower strata of the soil, the cover-crops assist aeration of the ground. (6) Grown in avenues between rubber trees, a much-needed degree of coolness is maintained, which is specially beneficial in periods of drought. (7) The amount of nitrogen in the soil

is increased. (8) The growth of weeds is appreciably retarded and is eventually smothered.

The cover crop should be a perennial, hardy, free seeder, and should rapidly cover the ground. If a creeper, it should be easy to dig in and not twist too strongly, and if a shrub it should not be too woody. When, after two or three years, its purpose has been fulfilled, it should be easily eradicated. The following are plants which have so far given good results: *Centrosema Plumeri, Mimosa invisa, Nephrosia candida*, and *Mikania scandens*. For practical details as regards suitability and methods of planting the original article should be consulted.

Latex Yields.—The *Arch. v. de Rubb. Ned.-Indië* (June 6, 1922, p. 195) contains an interesting article on the rubber estates of the future by Victor Ris. He first deals with the influence of the selection of planting material and then with that of the selection of the soil on latex yields.

As regards the selection of planting materials, it is considered that an estate now yielding 400 lb. of rubber per acre per annum might have the yield increased to as much as 2,000 lb. per acre by grafting selected high yielders on to the root system of ordinary young trees. As regards soil selection, it is considered that the quality of the soil is a prominent factor in determining the yield of the rubber trees, and that by suitable soil selection the yields can be increased by 50 per cent., thus rendering it possible to obtain 3,000 lb. of rubber per acre per annum on an ideal estate. Taking into account the need for "resting," the variation in the skill of the tapper, and other factors, it is estimated that 1,200 lb. of rubber per acre ought actually to be reached on estates.

Rubber from Young Trees.—It is well known that trees below the ordinary tapping age give rise to an inferior rubber. Dr. de Vries (*Arch. v. de Rubb. Ned.-Indië*, August 6, 1922, p. 308) gives an account of experiments on four groups of trees from 3 to 4½ years old. He found the amount of rubber in the latex was low, 20–30 per cent. The rubber, especially in sheet form, was brittle or "short." The tensile strength of the vulcanised rubber was 1·20 against 1·49 for ordinary vulcanised rubber. The time of vulcanisation was remarkably short, being very similar to that of "matured" rubber from older trees. The viscosity of the rubber solution was very low, especially for crêpe. Dr. de Vries remarks that, after the trees have reached the usual tapping age, the age of the tree has less influence on the rubber than is generally supposed. The

older trees give rise to a somewhat slower curing rubber than the young trees, but there is no improvement in the tensile strength.

FIBRES

Silk.—In the *Commercial Bulletin, Dept. of Commerce and Industry, Palestine* (1922, **2**, 96), reference is made to sericulture in Syria and the Lebanon. The industry has been passing through a very critical period, but is now recovering its activity. In 1921, 68,000 boxes of eggs were imported, which were all of French origin with the exception of 3,000 boxes from Italy. It is estimated that the next crop should be about 1,200,000 okes (30,000 cwts.) of fresh cocoons or 490,000 okes (12,000 cwts.) of dry cocoons, yielding 1,250 to 1,500 bales of silk. Before the war the annual production was much greater and amounted to about 4,000 bales of silk. The present revival of the industry is regarded as very promising.

During a visit to Bangkok, Mr. F. W. South, M.A., Chief Agricultural Inspector, Dept. Agric., Federated Malay States and Straits Settlements, made a study of the present position of the silk industry in Siam, and the results are incorporated in an article in the *Agric. Bulletin, Federated Malay States* (1921, **9**, 258).

Silk weaving is carried out by means of hand looms, mainly in the villages of Chieng Mai, a northern district, and on the Korat plateau in the east. The raw silk used in Chieng Mai is brought overland from Mandalay in Burma, and is spun and woven into a fine silk cloth by the Siamese women. On the Korat plateau the silk is imported from the adjacent parts of Cambodia and is used for the manufacture of Siamese garments of fine quality which realise high prices.

Sericulture is practically confined to the Korat plateau where the mulberry silkworm is reared. Two varieties of the silkworm are produced, the larvæ of one of them being nearly white, whilst those of the other are strongly striped. The Siamese worm is reported to be the smallest in the world, and to give the lowest yield of silk, but it is hardy and disease-resistant. All the work is done by the women, and the silk thread produced is of very low grade. It is never woven in the local looms, but is sold to Chinese and Indian dealers who dispose of it in India, where it appears to be used mainly for purposes of adulteration or for the manufacture of goods of very poor quality. Sericulture is a very old-established industry on the Korat plateau, but has seriously degenerated.

About nineteen years ago the Siamese Government made an effort to improve the silk-rearing industry, and engaged an expert Japanese sericulturist, who, with the aid of a number of Japanese assistants, started a silk farm and school in Korat and introduced the best Japanese methods and appliances. Girls from the villages were paid good wages by the Government to work and learn at the farm and school. On returning to their villages, however, the girls took no further interest in what they had learned, but resumed the old bad methods which required less trouble. An improved strain of moths was produced at the farm and the eggs were distributed gratis to any Siamese who asked for them. Very little interest was displayed, however, and those who obtained eggs took no special care of them. The Government also distributed improved Japanese implements, free of charge; but no use was made of them. The Japanese workers found certain parasites of the silkworms and warned the Siamese that these must be kept away from the caterpillars, but again their teaching was fruitless.

Ten years later, the question was reconsidered. It was found that the silk produced in the villages had not improved but rather deteriorated, in spite of the fact that at the farm the Japanese were obtaining silk of excellent quality. The farm was therefore closed, and at the present time no trace remains of the work done by the Japanese. The effort thus met with no response from the people, and, in consequence, it was a complete failure.

Kapok.—Attention has recently been directed to the commercial possibilities of kapok cultivation in Malaya, and an article (reprinted from the *Straits Times*) has been published in the *Malayan Agricultural Journal* (1922, **10**, 51). In the Federated Malay States and Straits Settlements kapok trees occur in nearly all districts, but the amount of fibre obtained from them is insufficient to meet the local demand, except in Lower Perak, Kuala Kangsar and Krian Districts, which together contain about 60,000 trees. The purchase of kapok by the Chinese has yielded such poor returns to the Malay growers that the latter sell only a small proportion of their crop and much of it is left to rot. In the Straits Settlements there are only about 10,000 trees. Perak offers the best prospects for the establishment of a native industry, and the Department of Agriculture is taking steps to organise it. The Malays state that the kapok tree flourishes best on land which is periodically flooded and that hilly land is unsuitable. Care should be taken not to plant kapok on land which is very

subject to white ants, as these pests cause serious damage to the trees.

In the *Netherlands Indies Review* (1922, **3**, 209) reference is made to the kapok industry of the Dutch East Indies. Semarang is the chief exporting centre, and more than half the foreign shipments pass through this port. The Chamber of Commerce at Semarang annually fixes standards for superior Java kapok first quality (prime) and fair average Java kapok. There are a number of other grades, such as Soerabaya, Porrong and Madura, but the prime Japara (Java) kapok is the grade most attractive to buyers.

The exports of kapok from Java and Madura in 1921 amounted to 17,538 metric tons, of which 4,436 tons were shipped to Holland, 10,078 to the United States, and 1,967 tons to Australia. A small quantity is also exported from the Outer Possessions of the Dutch East Indies, the quantity shipped in 1920 being 471 metric tons.

Sisal Hemp.—Reference was made in this BULLETIN (1922, **20**, 101) to the cultivation of Sisal hemp in Jamaica. Information regarding the progress of this new industry is given in the *Ann. Rep. Dept. Agric., Jamaica, for the year ending 31st December*, 1921. It is stated that at the time of the report manufacture and export were commencing and that the factories in Clarendon and the Government establishment at Lititz would all be in operation during 1922. At May Pen, in Clarendon, 600 acres were being cut. The cordage factory in this district was expected shortly to commence the manufacture of ropes.

In the Government plantation at Lititz, which occupies 1,100 acres of Crown lands, 1,000 plants were selected for test purposes, and leaves cut from these during the years 1919, 1920 and 1921 gave the following results:

	Nov. 1919.	Nov. 1920.	Nov. 1921.
Average no. of leaves fit to be cut per plant	32	30	31
Average yield of leaves per plant . *lb.*	19	18	16·5
Average weight of a single leaf . . *ozs.*	9·6	9·7	8·5
Recovery of fibre (by hand) . *per cent.*	3·4	3·93	5·7
Fibre per 1,000 plants . . . . *lb.*	646	759	940
Yield per acre at distance of 6 ft. by 5 ft. *lb.*	938	1,029	1,433

These results are regarded as very encouraging and as fully justifying the enterprise, which is proving very beneficial to the people of the district and promises to be of great value in this drought-stricken area.

The Lititz factory has been erected at the northern

extremity of the plantation, so that the adjacent lands which are in private possession may be planted with Sisal hemp and the leaves sold to the factory on a co-operative basis. The factory is prepared to pay 2 per cent. of the price of Sisal hemp, f.o.b. Kingston, for leaves delivered at the factory; thus, if the fibre was selling at £30 per ton the price paid for the leaves would be 12*s.* per ton. In addition, a bonus, representing half the profits, will be paid at the end of the season. There are about 1,000 acres of land within two miles of the factory which are suitable for Sisal hemp cultivation, and 200 acres of this have already been planted by one of the landowners. The Lititz Board is willing to advance £2 per acre for approved plantations to be established within three miles of the factory.

Cotton

West Indies. *St. Kitts-Nevis.*—Reference to the cotton industry is made in the *Rep. Agric. Dept., St. Kitts-Nevis*, 1920–21. The area devoted to Sea Island cotton in the Presidency during the year was about 5,500 acres, of which 1,500 were in St. Kitts, 3,000 in Nevis, and 1,000 (estimated) in Anguilla. The crop in Anguilla was lower than the average owing to lack of rain. The presence of the pink boll-worm was discovered in March. The season was also unfavourable in St. Kitts and considerable damage was caused by insect pests; much of the later-planted cotton had to be destroyed, as it had become attacked by the pink boll-worm, which was first discovered in the cotton at the Government Experiment Station in November 1920. In Nevis, the cotton seed germinated well, but owing to a spell of dry weather the plants were killed and all the fields had to be replanted. In spite of this, however, record yields were obtained.

The seriousness of the pink boll-worm invasion is fully appreciated, and as a means of controlling the pest an Ordinance (No. 12 of 1920) was passed fixing February as a close season throughout the island of St. Kitts, and ordering that all cotton plants should be destroyed by burning on or before January 31. Regulations were also made for the control of cotton ginneries, fumigation and disinfection of seed for planting, and for controlling the transport of seed and all bags and packages used therewith.

The exports of cotton from the Presidency during the years ended September 30, 1919 and 1920, were as follows:

Year.	St. Kitts. lb.	Nevis. lb.	Anguilla. lb.	Total. lb.
1919	442,681	307,212	47,869	797,762
1920	288,720	292,627	61,543	642,890

Manurial experiments with cotton have been carried out by the Agricultural Department for the past sixteen years, and the results of those made in 1919–20 and the average results for the whole 16 years are now recorded.

Seed selection work has also been continued, efforts being directed to the production of a strain combining high weight of lint per seed with a fine staple of over 56 mm. (2·2 in.) in length. Some interesting strains have been developed and, although it has been found quite easy to evolve a strain with a large amount of lint per seed, it is still uncertain whether it is possible to combine with this the production of long, fine and lustrous lint.

Montserrat.—According to the *Rep. Agric. Dept., Montserrat*, 1920–21, the area devoted to cotton in that season was about the same as in 1919–20, viz. 3,200 acres. The exports, consisting of practically the whole crop, amounted to 395,035 lb. or 1,043 bales of white Sea Island cotton, no stained cotton being shipped. The average yield of lint per acre was thus 123 lb., as compared with 171 lb. in the previous year and 145·9 lb. during the whole period of cultivation since 1903. The low yield was caused by the lack of rain. The crop was comparatively free from pests and diseases, except for the discovery of the pink boll-worm towards the end of the season and slight attacks of the leaf-blister mite and cotton worm.

The presence of the pink boll-worm was detected by Mr. W. Robson, Curator of the Botanic Station, in November 1920, and on further investigation it was found that, in the first instance, the infestation had occurred only on estates adjoining the town and harbour of Plymouth and that in several fields the proportion of punctured bolls ranged from a few up to 40 per cent. The outbreak was studied by Mr. H. A. Ballou, Entomologist of the Imperial Department of Agriculture for the West Indies, who made the following recommendations for controlling the pest: (1) Every cotton field should be thoroughly cleaned up, with the removal of all old plants, scattered bolls and pieces of seed-cotton, and similar methods should be applied to cotton storehouses and ginneries. (2) This cleaning up should be completed not later than December 31, 1920, and the planting of the next crop should not take place earlier than March 1921. (3) All ginneries, store-rooms, cotton-houses and adjoining premises should be cleaned and freed from cotton not later than April 1, 1921. (4) All seed not intended for planting purposes should either be shipped to England or destroyed by burning not later than April 1, 1921. (5) All seed intended for planting

should be treated by heat. (6) Districts unaffected with the pink boll-worm should be planted only with seed from uninfested districts. These recommendations have, in the main, been incorporated in an Ordinance (No. 1 of 1922) referred to below.

For carrying out the heat treatment, the Montserrat Company, Ltd., voluntarily offered the use of their citrate drier, and experiments with this machinery were quite successful, a constant temperature of 55° C. being easily maintained. The whole of the seed used for planting the 1921 crop, amounting to approximately 60 tons, was treated in this drier, the Company only charging the actual working expenses.

The Cotton Close Season Ordinance (this BULLETIN, 1922, **20**, 202), which had previously declared the month of February to be the period when no cotton plants should occupy the ground, was changed for the greater part of the island to include both January and February. The pink cotton boll-worm having been found also on okro plants, a general destruction of the latter was effected.

Cotton-breeding experiments have been carried on for many years by the Agricultural Department, and, in 1920, the work was chiefly concerned with selection of the strain, known as Heaton 23-2-13, which in 1919 gave the highest yield per acre of any cotton grown on the experiment plot. Full details of these experiments are given in the *Report*. Selection work was also carried out with the Heaton 9 type, but the data obtained demonstrated that none of the strains grown showed superior factors to those of the best of the Heaton 23-2-13 type and only two of them were retained for cultivation in 1921. Several interesting matters connected with this selection work are discussed.

An Ordinance (No. 1 of 1922) to provide for the protection of cotton was enacted in Montserrat in May 1922. The Ordinance empowers the Governor to prescribe a close season for any period of the year, either for the whole Presidency or for particular areas. It orders that all cotton plants shall be burned *in situ* before the preparation of the land for a new crop and before the first day of the close season, provides for the enforcement of regulations regarding the storage of cotton seed, seed-cotton or lint, for the appointment of inspectors who are authorised to enter any land, ginneries or cotton-seed storehouses and also to destroy any old cotton plants, and further provides for the establishment of regulations and for penalties for contravention of the Ordinance or any Regulation made under it.

Regulations were made under this Ordinance on July 10, 1922, and these were revised in October 1922. The revised regulations order that all seed-cotton shall be delivered at the ginneries by February 15 and that the whole shall be ginned by March 31, that all cotton refuse shall be removed from the cotton houses and yards by February 28 and from all cotton ginneries by April 15. All cotton seed must be fumigated in bulk or bags, and each ginnery must be equipped with adequate fumigation apparatus. Fumigation is to be effected by means of carbon disulphide, applied in the quantity of one pound per 120 cubic feet of the fumigation chamber, and must be continued for not less than 12 hours. The fumigation is to be carried out by a method which is described in the Regulations and must be done to the satisfaction of the Curator who has the right of access to any ginnery for the purpose of ensuring that the Regulations are being complied with. All cotton-seed storehouses must have concrete or close-boarded floors. All bags used in connection with cotton picking, etc., must be fumigated with carbon disulphide. All cotton-seed, except that to be used for planting, must be shipped, crushed or disposed of in compost pits by April 15, and the disposal in compost pits must be done in the manner approved by the Curator. All cotton seed for sowing must be fumigated a second time. A register, open at all times to the inspection of the Curator, shall be kept in each ginnery for recording (1) the amount of carbon disulphide (*a*) purchased from time to time, (*b*) in stock, and (*c*) used each day, (2) the quantity of seed-cotton ginned daily, and (3) the quantity of cotton seed fumigated each day. The close season and certain other provisions of the Ordinance shall apply to okro plants as well as to cotton plants. Other regulations relate to precautions to be observed in transporting seed-cotton from one place to another, and for the importation, control and distribution of carbon disulphide by the Agricultural Department, who shall keep an account of the quantity supplied to each ginnery.

Fiji.—During the American civil war, and for some time afterwards, cotton was Fiji's chief export. Even in 1875 it was the second in value, although the amount exported had considerably decreased. From that time the industry continued to decline, and, although proposals were made from time to time to restart it, no cotton has been cultivated in Fiji on a commercial scale for many years, with the exception of a small plot on the Lautoka Experiment Station which was maintained until 1917.

A type of "kidney" cotton grows wild in the Colony and a few hundredweights of lint of this variety have been exported from time to time.

The quantities and value of the cotton exported from Fiji during the years 1907–21 were as follows:

Year.	Quantity. cwts.	Value. £	Year.	Quantity. cwts.	Value £
1907	27	100	1914	31	206
1908	29	189	1915–16	nil	—
1909	nil	—	1917	11	64
1910	18	103	1918–21	nil	—
1911–13	nil	—			

In 1920 preparations were made to revive cotton growing in Fiji and a quantity of seed was ordered for sowing. While this seed was *en route* to the Colony, however, a pest was reported to be prevalent in the country from which it had been dispatched and the whole of the seed was therefore destroyed.

According to the *Agricultural Circular, Dept. Agric., Fiji* (1922, **3**, 15), a further attempt is now being made to re-establish the industry. As Sea Island cotton has already proved well adapted to Fiji, arrangements were made with the Imperial Department of Agriculture for the West Indies for the supply of 6,000 lb. of seed of this variety from Barbados to arrive in the Colony in ample time for planting in December or January. The British Cotton Growing Association has offered to supply roller ginning machinery up to the value of £500 to be paid for by instalments extending over three years. The Association has also undertaken to make advances to growers on shipment of their cotton up to 70 per cent. of its market value. Enquiries are being made by the Fiji Government regarding the guarantee of a fixed minimum price for cotton for a period of years.

In a more recent number of the *Agricultural Circular* (1922, **3**, 36) an account is given by H. W. Simmonds, F.E.S., Acting Government Entomologist, of the principal insect pests of cotton existing in Fiji.

The cotton boll-worm (*Earias fabia*) was found on cotton at the Lautoka Experiment Station and was controlled by picking off the affected shoots by hand. As this pest is commonly present on species of Hibiscus, all such plants should be destroyed in the vicinity of cotton plantations. A close season of two months' duration during which no cotton may be grown is also recommended as a measure of control.

The pink boll-worm (*Gelechia gossypiella*) was only discovered in Fiji in June 1922, when it was found attacking Sea Island cotton at Nadi. The whole country between

Penang and Nadi was therefore carefully inspected and the presence of the insect was established at several points along the coast, particularly at Penang, Rabulu, Teidamu and Ba. The pest was subsequently found at Bua and Macuata. It is not known when the insect was first introduced into Fiji, but it has evidently been present for several years. In the collections of the Department of Agriculture there is a damaged specimen of a moth, labelled "Suva, November, 1906, bred from larva found in cotton seed," which is almost undoubtedly *Gelechia gossypiella*. In order to control the pest, a close season of two months is recommended, together with the destruction by fire of all old plants at the end of the cotton season.

It is stated in the *Times Trade Supplement* (December 23, 1922, p. 339) that the Fiji Government has acted on Mr. Simmonds's advice, and has ordered the destruction of all cotton plants throughout the Colony and also declared a two months' close season.

Among other pests mentioned by Mr. Simmonds are cut-worms, cotton stainers (*Dysdercus insularis* and *D. impictiventris*), shield bugs (*Tectocoris lineola*), mealy bug (probably *Pseudococcus virgatus*), green fly (*Aphis gossypii*), and brown scale (*Lecanium* sp.?).

FORESTRY AND FOREST PRODUCTS

Forests of Sierra Leone.—According to the *Annual Report of the Forests Department, Sierra Leone*, for the year 1921, the destruction of forests in that Colony continued unabated during the year. Large areas of high forest were cleared for the cultivation of rice by the native farmers, who have not yet learnt the important bearing that forests have on climate in maintaining and promoting moisture. The formation of further forest reserves is of primary importance, but with the small staff of forest officers available, this is not an easy matter and in time will become still more difficult as large areas of uninterrupted forest become scarcer. At the end of the year the total area of forest reserves was 208 square miles, only 0·58 per cent. of the total area of the country. Of this amount 67 square miles were reserved in 1921, comprising the Nimmini North Reserve (48½ sq. miles), Nimmini South Reserve (10 sq. miles) and Dodo Hills Reserve (8½ sq. miles). The first-named reserve is on a range of steep hills covered for the most part with virgin forest. In places, however, the forest has been felled for rice farming, an exceedingly dangerous practice in view of the rapid erosion likely to occur owing to the steepness of the

hills and the heavy local rainfall. On account of its remote situation it is unlikely that the reserve will have any direct commercial value for a long time, its chief value being for the preservation of the climatic conditions essential to agriculture.

The Nimmini South Reserve lies in hilly country, the soil varying from bare rock on some of the hills to deep soil and swamp in the valleys. The vegetation varies accordingly from grass to good stands of timber. The reserve is the remnant of a large area of forest, rice farmers having made inroads from all directions, farming in the valleys and as far up the hills as soil could be found. Soil erosion has consequently been serious and this reserve also is mainly of value at present as a protection forest. The vegetation is of the usual rain forest type, the chief trees being the following: *Polyadoa Elliottii* (" koffei "), *Heritiera* sp. (" yawi "), *Terminalia superba* (" kojagei "), and *Terminalia* sp. (" bagi "), which occur abundantly, and *Baphia nitida* (" bunduei "), and an unidentified species known as " kpwindi," which are fairly plentiful, the latter being a small tree yielding a wood said to resemble Polyadoa and forming practically pure stands on poor soil. A few trees of *Lophira procera* (" hendui "), *Mitragyne macrophylla* (" mboi "), and " bili " occur and occasional specimens of *Cordia platythyrsa* (" pooli ") and " njeli." It is possible that certain of the rivers could be used for floating logs from this forest to the railway at Daru, but it seems doubtful whether this could be done profitably.

The Dodo Hills Reserve is of importance as a protection forest on account of the numerous small streams that spring high up the slopes of the range. Many useful timbers of good size are common, and there seem no insuperable obstacles to extracting and marketing them. The southern limit of the reserve is only six miles from Panguma, and the present motor road connecting that place with the railway twenty miles away might be extended to the reserve at no great cost. Moreover, it may prove possible to float logs down the Bundeya (or Mundoya) River during the rainy season.

Thingan and Gurjun Timbers.—To the series of Indian *Forest Bulletins* dealing with the distribution, characters, outturn, etc., of certain Indian timbers have recently been added two dealing respectively with thingan and gurjun or kanyin (*Forest Bulletins*, Nos. 49 and 50, 1922). In each case a thin veneer of the actual wood is bound up in the Bulletin.

Thingan (*Hopea odorata*, Roxb.) occurs over very large areas of forest in Lower Burma, Arakan, Tenasserim and the Andaman Islands. It is a tall, straight tree reaching a height of 150 ft. and a girth of 12 ft., and provides clean logs of 40 to 80 ft. in length. The sapwood is pale in colour and the heartwood yellow to olive-brown, sometimes quite pale yellow. The timber is even-grained, hard and close in texture, with a very handsome silver grain on the longitudinal radial section. It works and polishes well and makes attractive panelling and furniture. Locally the wood is considered one of the best for boat-building, whilst sections cut from large trees are used as solid cart-wheels. It is also used in house-building, for bridges, and for other purposes where durability is required. The tree yields a resin known as "Rock dammar," suitable for making varnishes for indoor use. Two reports made by the Imperial Institute in 1904 and 1906 on this resin are printed in *Forest Bulletin* No. 49.

The names "gurjun" and "kanyin" are applied more or less indiscriminately to several species of *Dipterocarpus*, including *D. tuberculatus*, which was the subject of an earlier *Forest Bulletin* (No. 13), and *D. turbinatus*, *D. alatus*, *D. pilosus* and other species, which are now dealt with in *Forest Bulletin* No. 50. *D. turbinatus* occurs in the evergreen forests of Assam, Chittagong, Burma, the Andamans, and the lower levels of the Western Ghats. The other species are confined to the evergreen forests of Burma and the Andamans, Siam and the Malay Peninsula. These species of Dipterocarpus are amongst the largest of Indian trees, trees of 10 to 15 ft. girth at breast height, and 120 ft. high, with a clear bole of 60 to 80 ft., being comparatively common. Gurjun wood is reddish-brown and moderately hard. It is not durable when exposed to the weather, but lasts well under cover if protected from white ants. In India and Burma its main use has been for cheap planking in house-building. On the London market it finds a ready sale for flooring, parqueterie and panelling.

Sap-stain, Mould and Decay in Green Timber.—During periods of transit and storage, prior to its manufacture, green timber containing a high percentage of sapwood often suffers considerable damage. This may be due to "sap-stain," the growth of moulds, or incipient decay caused by wood-destroying fungi, the last-named cause being of chief importance. N. O. Howard, of the Office of Investigations in Forest Pathology, U.S. Department of Agriculture, has recently dealt with this subject, in co-

operation with the Forest Products Laboratory, Madison, in *Bulletin No.* 1037, 1922, *U.S. Dept. Agric.*

Sap-stain, or "blueing" of timber may be due to chemical causes or to the action of fungi, and must be distinguished from the blue-purple stain caused by the action of tannic acids in the wood on rusty saws used in cutting the timber and also from the colorations due to the presence of superficial moulds or to the action of the more or less deep-seated sap-rot. Chemical sap-stains are caused by oxidising ferments, the degree of staining increasing up to a certain point with an increase of temperature and humidity. Such stains can be prevented by dipping the timber in boiling water for a few minutes, and in the case of kiln-dried lumber the discolorations are obviated to some extent by the use of comparatively low temperatures for drying (120° to 125° F.) and corresponding low humidities (50 to 70 per cent.). Chemical stains are not of very common occurrence, and they do not impair the strength or durability of the timber. In general, therefore, they are not of great economic importance.

The sap-stain fungi which cause discoloration of the wood are of several kinds, the chief being species of *Ceratostomella*, *C. pilifera* having been found in the sapwood of several species of pine (*Pinus*), fir (*Abies*), oak (*Quercus*) and ash (*Fraxinus*). The spores of the fungus become deposited by the wind or insects on broken ends of branches, and in holes made in the bark and wood of the living tree by boring beetles ; or on the cut surface of sawn timber. The hyphæ which develop penetrate ultimately into the wood through the medullary rays and attack the cells stored with food material. They do not appear to attack the hard lignified tissue of the wood and consequently blued wood is practically as strong as unstained wood. The presence of much stain, however, will prevent the use of timber for purposes where colour, texture and clearness of grain are of first importance. The cause of the blue colour in the wood has never been satisfactorily explained.

Moulds commonly develop on timber stored under moist, warm and stagnant conditions, producing discoloration owing to the presence of coloured hyphæ or to a luxuriant superficial growth of coloured spore masses. Numerous forms have been identified at one time or another, including a large number of species of *Graphium*, *Aspergillus*, *Penicillium*, etc. These stains are superficial and are readily removed when the timber is planed. The moulds, as in the case of the sap-stain fungi, do not affect the strength of the wood, but their presence indicates

the existence of conditions favourable to the development of decay, and for this reason buyers would be likely to look with suspicion on timber which is coloured by them.

Numerous experiments were conducted with a view to preventing sap-stain and mould. By far the most effective method is proper kiln drying. The staining fungi can be controlled to some extent by steaming and the use of antiseptics. Of the latter, a 1 per cent. solution of mercuric chloride gave the best results against both sap-stain and mould, whilst borax (1 per cent.) was effective in controlling the sap-stain fungus and was partially successful against mould.

In general, the best remedy consists of a combination of the following measures : Care in the selection of raw stock in order to obtain, if possible, material free from fungus infection ; expedition in the movement of raw stock from the felling of the logs to that time in the process of manufacture when the material becomes sufficiently dry to resist the attacks of fungi ; provision at all times for ample ventilation of the stock that it may quickly become at least surface-dried and so lessen the chance of infection ; the kiln drying of the stock wherever possible and whenever the cost will permit ; and in special cases steam treatment or the use of antiseptic dips, followed by proper piling to ensure ample ventilation.

MINERALS

Aluminium

India.—In *Records of the Geological Survey of India* (1921, **53**, 250), L. L. Fermor briefly describes the bauxite deposits of Bihar and Orissa.

The deposits of greatest accessibility and importance are those forming parts of the laterite caps overlying the Deccan Trap formation on the plateaux of the Palaman and Ranchi districts at elevations of about 3,200 ft. Of these Pakri Pat and Serendag in the Ranchi district are the most important and exceed in value the longer known deposit at Netarhat in Palaman. The laterite deposits in the Ranchi district have an average thickness of about 30 ft., the bauxite occurring in them as local segregations, especially near the edges of scarps and along streams.

Bauxite also occurs in the laterite capping of the Khondalite hills of Kalahandi State at elevations of 3,200 to 4,000 ft., but even if this laterite should prove to be rich in bauxite it is too remote to be worked under present conditions.

Picked specimens of bauxite, one from Korlapat, Kalahandi, and another from Netarhat in Palaman, contained respectively 67·88 and 64·64 per cent. of alumina, 0·93 and 1·79 per cent. of silica, and 1·04 and 3·30 per cent. of titanium dioxide. The average composition of the Ranchi ores, which also represents bauxite of good grade, is about 51·5 per cent. of alumina, 0·3 per cent. of silica, and 14 per cent. of titanium dioxide.

Gold Coast.—According to the *Report of the Geological Survey of the Gold Coast*, 1921, further discoveries of bauxite deposits have been made in the Colony. These are in a group of hills from 4 to 6 miles N.N.E. of Sefwi-Bekwai. The largest deposit is on Mt. Supirri, which is about 1,000 ft. higher than the Sefwi-Bekwai road at Atruinso. On the southern spur of the mountain, rising from the Atruin River, bauxite forms the surface material for the uppermost 850 ft. and occurs as a thick cap on the summit. On one face near the summit the deposit is about 90 ft. thick at one point and from 30 to 50 ft. at others.

The ore varies in quality. Some of it is of high grade, while much of it is highly ferriferous. In general, the ore is of lower quality than that found at Mt. Ejuanema, but it occurs in much greater quantity. Bauxite also occurs on the tops and flanks of several of the adjacent hills.

An interesting feature of these bauxite deposits is that in some cases they carry both gold and silver in appreciable quantity. It is suggested in the *Report* that the gold and silver might be worth recovery from the insoluble residues which would result from the treatment of the bauxite by the Bayer process.

On Mt. Kawkawti, near Akwadum, the capping was found to consist of a thick mass of lateritic material, including limonite, hæmatite and bauxite. Some of the latter is said to be of good quality, although generally it is highly ferriferous.

Chromium

India.—In *Records of Geological Survey of India* (1921, **53**, 255), L. L. Fermor refers to the chromite deposits of Bihar and Orissa. The ore occurs as segregations and bands in the partially serpentinised peridotites forming Roru Buru, Kimsi Buru and other hills in the Kohlan, west of Chaibasa. These deposits have been worked for several years, and during the five years 1914–18 yielded an average of 1,641 tons annually.

A feature of the magnesian rock outcrops of this district is the fact that they are less favourable to the growth

of vegetation than the associated slates. Consequently, in March, when the *sal* bursts into fresh leaf, the peridotite areas appear as brown islands in a sea of green. This fact seems to supply a ready means of discovering other areas of peridotite, should such exist, with possible chromite inclusions.

Coal

Federated Malay States.—Batu Arang, in the State of Selangor, the only coal-field being worked in Malaya, is described by T. L. McCall (*Bull.* 123, *Canadian Inst. Min. and Met.*, July 1922, p. 834; cf. *Imperial Institute Monograph on Coal*, 1920, p. 40). The main seam is 42 ft. thick, sometimes reaches 70 ft., and contains 37 ft. of coal. The Great seam, which is confined to one corner of the field, is upwards of 400 ft. thick, and contains one layer or leaf of coal 30 ft. thick, the upper 300 ft. consisting of thin coal, shale and sandstone. Borings and surface indications appear to suggest that the coal-field is quadrilateral in shape and measures 3 miles by 2 miles. The ultimate analysis of the dried coal gives an oxygen-hydrogen ratio of 4 : 1, and the material might be correctly classified as a sub-bituminous coal. The coal, worked by pillar and stall in panels, was very subject to spontaneous combustion, but hydraulic stowage of the waste, introduced by McCall, has proved successful in preventing fires. The material for packing the waste is tailing, composed of sand and gravel, obtained from an adjoining alluvial tin mine, but, instead of working the top leaf first as heretofore, the seam is now opened out in the lowest leaf, the waste being packed as the coal is extracted, and the next overlying leaf of coal opened out on the top of the packing, and so on. The packing sets firm, and there is not the slightest difficulty in working the coal above it, and fires no longer occur.

Union of South Africa.—The new coal-field in the Northern Waterberg, Transvaal, has been described by J. G. Trevor and A. L. Du Toit (*S. African Journ. Indust.*, April 1922, p. 164). Coal was first discovered on Grootgeluk farm in March 1920. A number of bore-holes put down subsequently proved that a large and important coal-field exists here, which is bounded on the west and north by the Crocodile or Limpopo River; on the east by the Sand or Pongola River; while it is limited on the south by unconformity or by a fault having a general E.W. trend, the eastern portion of it passing a little north of the Rooibok Hills. Coals have been recorded in every one of the bore-holes put down over a continuous area of 35 square miles. In addition to the area already proved, it is

almost certain that there is a considerable extension towards the north-west. A 500-ft. bore-hole at Grootgeluk, while not piercing the whole of the Karroo strata, proved towards that base 62 ft. of black barren shales, which have been correlated with those of the Lower Ecca series that underlie the coal measures in Natal, and which have also been recorded from bore-holes near Palapye in the Bechuanaland Protectorate, just above the glacial conglomerate (Dwyka series). The coal measures themselves belong to the Middle Ecca series of the Karroo system. Above the shales are about 120 ft. of sandstones, with which is associated a lower group of seams; above that, a continuous series of alternating thin coals and black shales, 280 ft. in thickness, of which 113 ft., or two-fifths, are actually coal; towards the top of these is the upper group of seams overlaid in turn by barren shales. From analyses of core-samples of coals obtained, it appears that the lower seams, below 300 ft., correspond to the ordinary Transvaal and Natal qualities, but that the upper seams are of a different and more bituminous nature than any worked in the country.

At the present time this coal area, owing to its geographical position, is, of course, unworkable, but whenever a railway is constructed to connect the Transvaal railway system with the Bechuanaland Railway, it will traverse the area, thereby not only enabling the coal but also the big iron deposits of Vliegepoort, on the Crocodile River, to be opened up.

The first volume on the coal resources of the Union of South Africa, by W. J. Wybergh, has been published recently (*Union of South Africa Dept. Mines and Industries, Geol. Survey Memoir* 19, 1922). This deals with the coal-fields of Witbank, Springs, and Heidelberg, Transvaal, and also with those of the Orange Free State. The Witbank coal-field is now made to include not only the Witbank area proper, described by E. T. Mellor in 1906 (*Geol. Survey Memoir* 3; cf. *Imperial Institute Monograph on Coal*, 1920, p. 73), but the extended area to the south, in which, since Mellor's investigations, important collieries have been opened up and numerous bore-holes have been sunk. Seam No. 1 is being worked at two collieries. The lower portion only of Seam No. 2 has been worked, and furnishes at present the greater part of the coal obtained from the Witbank coal-field. Seam No. 4, being inferior to No. 3, has been little worked hitherto. Seam No. 5, the uppermost of the series, has been largely denuded and is at present only worked at one colliery. Since Mellor wrote his report, the continuity of the coal measures and the

regular succession of individual coal seams has been proved to a large extent by bore-holes. The total coal reserves of the Witbank area, including "proved," "estimated" and "undetermined" areas, are given as 7,956 million short tons, covering 102,600 acres and having an average evaporative power of 11·19. In 1920 the output amounted to 5,334,822 short tons, of value £1,613,654.

The Springs area, although the field is small and contains only coal of poor quality, is of considerable industrial importance owing to its proximity to the gold-mining area. Several seams have been mined here, but their correlation has never been properly worked out, as they vary much in extent, thickness and quality. The coal, which has a low calorific value and high ash-content, has been described as a low-grade steam coal. The reserves in the "proved" and "unproved" areas are given as 485 million tons, with an average evaporative power of 9·08.

The Nigel area is at present being worked on a small scale at one place only. There appear to be three patches of coal, of inferior quality. The gross coal-contents are estimated at 153 million tons, of evaporative power between 8 and 9.

In the Vischkuil-Delmas area three seams are known, but the lower portion—averaging 10 ft. thick—of No. 1 seam is the only coal being mined in the district. The reserves of the proved and unproved areas are estimated at 1,629 million tons, having an average evaporative power of about 10.

The Heidelberg area includes the important South Rand coal-field. There are three seams at Grootvlei, the lower portion—7½ ft. thick—of the main seam (53¾ ft. thick) only being worked. The upper portion is said to be anthracitic. The reserves of this coal-field are estimated at 8,064 million tons, with evaporative power averaging about 10.

In other localities, the Vereeniging patch of coal measures is the second largest in extent, but, except at the old Camp Colliery, now worked out, is little known. The reserves of these other localities are given at 974 million tons, with evaporative power from 9·5 to 11·27 or "unknown."

The output of the Springs-Heidelberg coal-fields in 1920 amounted to 829,434 tons, of value £247,853.

There are two working coal-fields in the Orange Free State, namely, the Vereeniging and the Vierfontein fields. At the Cornelia colliery there are two principal seams, but the lower portion—about 8½ ft. thick—of the lower

seam (10 ft. thick) is the only coal being worked. The coal rests on dolomite in a very irregular way, the latter sometimes forming steep ridges below the coal, and it would appear that the basins of the region are situated in areas which contain lines of underground drainage in the dolomite, and that the dissolving away of the latter has caused in some places a gradual subsidence, and in others a sudden breaking in of the overlying strata. The coal is bituminous, non-coking and free burning. The coal at the Clydesdale colliery appears to be of slightly lower grade. The total proved and unproved coal for the whole field is estimated at 11,458 million tons, with evaporative power ranging from 8 to 11. In the Vierfontein coal-field there is at present only one colliery working. The seam has an average thickness of 7½ ft., and is very uniform in quality, the whole being mined. The coal is of slightly lower grade than that of the Vereeniging coal-field. The reserves are estimated at 729 million tons, with evaporative power from 9 to 10.

All the coal-fields described are believed by Wybergh to belong to the Ecca Series of the Karroo System. Several thin seams of coal have been found in the higher Beaufort and Stormberg Series of the same system, but they are unworkable.

The total reserves of the Orange Free State are probably considerably in excess of 100,000 million tons. The output in 1920 amounted to 966,034 tons, of value £286,199.

Spitzbergen.—The presence of commercial quantities of coal in Spitzbergen has been known for many years. According to R. N. Rudmose Brown, who has contributed an article on "Mining Development in Spitzbergen" to the *Scottish Geographical Magazine* (1922, **38**, 115), no serious attempt to develop the Spitzbergen coal resources was made until 1904, when an American enterprise was started, which to-day has attained considerable magnitude and supports a community of 500 persons.

Several other companies possess coal interests in Spitzbergen, including one British; the others are chiefly of Norwegian and Swedish origin. The coal hitherto produced and exported has been taken by Sweden, Norway and Finland. The production for the 3 years ending December 31, 1921, was 90,000, 130,000, and 210,000 tons respectively. A considerable expansion in the industry is expected. The coal reserves are estimated at 10,000 million tons.

Russia-in-Asia.—According to information compiled by the Geological Survey of Russia and published by the

Soviet Government (*Engineer*, October 13, 1922) the Kuznetsk coal-fields are the most important of Western Siberia. They occupy a valley, 136 square miles in area, intersected by the navigable river Tom and its tributaries, and consist of six separate deposits.

The proportion of coal to the total strata is 1·3 per cent. in the Kuznetsk area, but in some parts of Western Siberia it reaches 1·8 per cent., and in the Kemer field as much as 16 per cent.

The coal reserves of the Kuznetsk fields are estimated at 250 million tons. The quality of the coal is good, as it contains but little sulphur and yields from 2·5 to 6 per cent. of ash. In the Kemer field coal of a good coking type is found. This field yielded 420,000 tons of coal in 1914.

The Ekibastooz deposits of coking coal consist of several seams, of which only four have been worked. The coal reserves amount to approximately 500 million tons. The deposits are about 60 miles from the River Irtish, with which they are connected by railway. The Izikh coal-fields on the River Abakan consist of 12 workable seams, 3 ft. or more thick. The reserves down to a depth of 700 ft. are estimated at 50 million tons.

The Black Mountain coal-fields on the Yenisei River, about 15 miles from Minnussinsk, consist of several rich seams, but the area having been only slightly investigated, no estimate of the coal reserves is possible.

Copper

Canada.—The copper deposits of Lasqueti Island, British Columbia, have been described by J. D. MacKenzie (*Summ. Rept.*, 1921, *Geol. Survey, Canada*, Part A, p. 50). The deposit is a zone of crushed quartz-diorite, which intrudes metamorphosed volcanic rocks, with a strike of N. 25° E. In the Mars claim of the Venus group the width of the zone is from 4 in. to several feet. A shoot of nearly solid chalcopyrite with some pyrite and strips of crushed country rock occurs here. Up to December 1921, 196 tons of ore had been shipped to the Tacoma smelter, the returns from which averaged: copper, 12·82 per cent.; gold 0·63 oz., and silver 3·27 oz. per ton. The mineralisation is regarded as primary. In the less crushed portions of the zone the chalcopyrite occurs in thin lenses, probably formed partly by filling and partly by replacement. In the more crushed portions of the zone the ore has apparently replaced the crushed rock. On Hill 60 claim there is a mineralised zone from 2 to 4 ft. wide, traceable for 900 ft., which crosses the diorite and volcanic rocks alike. A sample of picked material from this claim contained:

copper, 14·4 per cent.; gold 0·38 oz., and silver 1·8 oz. per ton.

The mineralisation is similar, although less in extent, at the St. Joseph group of claims adjoining the Venus group on the east.

United States.—The copper deposits of the Pima district, Sierrita Mountains, Arizona, are described by F. L. Ransome (*Bull.* 725 J, 1922, *U.S. Geol. Survey*, p. 419). The Mineral Hill mine is being developed through a vertical shaft 700 ft. deep, with main levels at 500, 600 and 700 ft. No ore has been shipped as yet from these workings, but the mine is being explored and opened up. A large quantity of oxidised ore, however, was raised from the now abandoned Azurite workings in the upper part of the deposit. The Plumed Knight mine, in the same district, which is 350 ft. deep, also at one time produced similar ore from above the 150-ft. level.

Mineral Hill is composed of rather thin bedded quartzite, striking N.W. and dipping steeply S.W. To the south, an E.-W. fault, dipping S. 55°, separates the quartzite from metamorphosed limestone with similar strike and dip. This limestone is underlaid by, apparently intrusive, granite. The ore-bodies, which occur in the limestone close to the granite, are irregular in form. The ore, which is mainly pyrite intimately associated with chalcopyrite, magnetite, and apparently a little pyrrhotite, varies from massive sulphides and magnetite to a mixture of those minerals with quartz, garnet and other contact-metamorphic minerals.

The ore deposit of the adjoining Vulcan group of claims is apparently of similar contact-metamorphic origin. The mine is worked by an inclined shaft 560 ft. in depth. Ore shipped from these workings is said to have yielded 1,200,000 lb. of copper and 11,000 oz. of silver and to have contained, on the average, between 6 and 7 per cent. of copper. A fair amount of copper ore, containing silver, has been shipped from the Red Oxide claims, and much copper-silver-lead ore, carrying gold, has been shipped from the Copper Glance, Copper Queen, Minnie and Senator Morgan mines, near Twin Buttes. From 1907 to 1919, inclusive, the Pima district has produced 26,065,868 lb. of copper, as well as certain quantities of lead, zinc, gold and silver.

Diamonds

Belgian Congo.—The Kasai Diamond Fields of the Belgian Congo, referred to briefly in this BULLETIN (1921,

19, 237), have been described recently by Henri de Rauw (*S.A. Min. and Eng. Journal*, August 26, 1922).

Diamonds have been discovered in the Kwilu Basin up to the confluence of the Kwilu with the Kwango in the west; up to the Lomami Valley below Kisengwa in the east; up to the sources of the Kwanza and of the Kubango (a Zambesi tributary) in the south; and the fields probably extend in a southwest-northeast direction.

Thirteen different fields are being worked in the Kasai tributaries by the Forminière Company, and the working of additional fields is contemplated; nine fields in Angola by the Société des Diamants de l'Angola; and one field in the Lubi and Bushimaie Rivers (tributaries of the Sankuru River) and many tributaries of the Lower Lulua River, by the Société Minière du Beceka, which contemplates working three others.

Gravels yielding one carat per cubic yard are considered to be very satisfactory; in exceptional cases they contain four, five, or even more carats per cubic yard.

The weight and quality of the stones vary with the locality. A high proportion of the Kasai diamonds have the form and limpidity of diamonds of the highest quality. While some are lightly yellowish or lightly brownish in colour, there are more distinctly coloured stones, including, as well as distinct yellows and browns, some clear green, blue and quite red diamonds and "boort."

The sizes of the stones vary from one-thirtieth of a carat up to 18 and even 20 carats each, the latter being the largest stones found in the Kasai basin. The average size is one-tenth or one-twelfth of a carat.

Gold

Tanganyika Territory.—The gold deposits south of Lake Nyanza, near Mwanza in Tanganyika Territory, which were developed to a limited extent by the Germans, are described by H. Rose Martin in *S.A. Min. and Eng. Journ.* (August 26, 1922). Mwanza, or Sekendi, near which the mines are situated in two distinct neighbouring areas, can be reached either by the Central railway from Tabora and thence 130 miles by road, or by rail from Mombasa to Kisumu on Lake Nyanza and thence by steamer. The gold occurs in quartz veins, apparently related to intrusive diorite dykes, in quartzites, slates and shales. These veins appear to have an average width of about 3 ft. and to carry good gold contents on the surface.

Milling tests of ore obtained from two small mines indicated 18 dwts. and 21 dwts. of gold to the ton respectively.

Canada.—The placer deposits of Cedar Creek, Cariboo district, British Columbia, are described by W. A. Johnston (*Canadian Min. Journ.*, November 10, 1922, p. 762). Placer gold was discovered near Cedar Creek in the autumn of 1921, and mining and prospecting in the vicinity, late in the summer of 1922, resulted in the finding of pay gravels, which differ in character from, and are much richer than, those originally found. The first discovery was made in a shallow depression about one mile from Quesnel Lake. In the discovery pit there is very little overburden, and the gold occurs in broken bedrock and in crevices in the solid bedrock. The gold is coarse and nuggety and is only slightly worn. In Platt's claim, yellowish or red pay-gravels, from 1 to 5 ft. thick, are found beneath an overburden of glacial drift from 6 to 10 ft. in thickness. Much of the gold is flattened and worn. These gold-bearing gravels have been found at a number of points for 2,000 ft. along the course of the supposed channel. The gravels are apparently glacial outwash or reworked ancient stream gravels, for they are only slightly weathered.

In the summer of 1922 a body of remarkably rich gravels was found 600 ft. above Platt's cabin, that is at a high level above the present drainage. The pay-gravels are reddish, rest on bedrock, and are covered by 1 to 10 ft. of barren glacial drift. They average 3 ft. in thickness. The gold is coarse—nuggets up to $3\frac{3}{4}$ oz. have been found—and only slightly worn. In September 1922 the daily output with two rockers varied from 28 to 101 oz. These gravels are evidently older than the glacial drift. If in place, they indicate the occurrence of an old stream channel at the level at which they lie.

Placer mining in Barkerville Area, British Columbia, has also been described by W. A. Johnston (*Summ. Rept.*, 1921, *Geol. Survey, Canada*, Part A, p. 59). The gold-bearing gravels are in part post-Glacial, but by far the most important are pre-Glacial or Tertiary. Glacial drift is abundant in the area and consists in part of boulder clay and moraine material; in part of stratified sand and silt; and in part of stratified gravels and bouldery deposits. The post-Glacial gravels form the surface gravels in the valley bottoms, and also occur as benches, but they are only of local importance. The pre-Glacial gravels consist of bench and creek gravels largely buried beneath the drift deposits, although some occur near the surface. They are generally only a few feet in thickness, and are in places characterised by heavy iron minerals, and by pebbles or

boulders of galena and barytes, and occasionally by scheelite. Many of the deposits contain large angular slabs of rock ("slide-rock"). The gold in places extends downwards for several feet along the bedding-planes and fissures in the bedrock.

Gold was first found in Antler Creek in 1860. The dredging ground of this creek was tested by Keystone drilling in 1915, and was proved to have a length of at least 4,000 ft. The pay-gravels have an average width of 140 ft., and an average depth of 48 ft., giving a total of 1,000,000 cub. yds. The average value per cub. yd. may be taken at 45 cents. Very rich alluvial deposits, both pre- and post-Glacial, have been worked in Williams Creek, as well as in the tributary known as Conklin Gulch. The Forest Rose property is a buried channel lying east and parallel with the lower part of Williams Creek. It has been worked as a hydraulic mine for over 30 years. The dredging ground of Williams Creek is 8,000 ft. in length. The ground, tested by Keystone drilling in 1914–15, showed pay-gravels averaging 240 ft. in width, 59 ft. in depth, and containing approximately 4,000,000 cub. yds. The average value may be taken at 28 cents per cub. yd.

There is a probability of dredging being started before long on Antler Creek, and, possibly, at other places in the region.

The Surf Inlet gold-mine, on Princess Royal Island, British Columbia, is described by V. Dolmage (*op. cit.*, p. 30). This deposit, though discovered many years ago, only began producing on a large scale in 1917. It is now an important gold producer of the province, and, in 1920, 108,082 tons of ore were mined, yielding 9,687 tons of concentrate, which gave 44,015 oz. of gold, 20,104 oz. of silver, and 685,259 lb. of copper. The mine is now developed down to the 1,000-foot level and has approximately 50,000 ft. of underground workings. An adjoining property, the Pugsley, now being developed by the company owning the Surf Inlet mine, is expected to start production shortly. The ore of the Surf Inlet mine occurs in large pyritised quartz veins, in places 37 ft. wide, which lie in a zone of intense shearing, that cuts the rocks of the Coast Range batholith in a N. 3° E. direction, and for a certain distance passes through an inclusion of chloritic schist. On the 50-foot level the country rock consists almost entirely of schist; on the 200-foot level it is half quartz-diorite and half schist; on the 550-foot level, where the ore reaches a maximum in both width and gold content, there is very little schist to be found. In general, slightly

higher values are found where the veins lie in schist than where they lie in quartz-diorite. The highest gold contents are also found where the dips and widths of the veins are most irregular. The ore occurs principally in two large quartz-veins, one on each wall. In the upper levels the veins are from 100 to 160 ft. apart, but they gradually converge until, at the 550-foot level, they form one large vein, which persists to the lowest level. The average dip of the veins is W. 45°. Their margins are almost invariably made up of a number of alternating bands of quartz and sericitised country rock. The pyrite, which carries the gold, lies in streaks and bands parallel to the bands of included country rock. The principal gangue is quartz, with a good deal of ankerite, and some calcite, dolomite, etc. Besides pyrite, the minerals chalcopyrite, native silver, chalcocite, bornite, covellite, hæmatite and molybdenite also occur in the veins.

The gold-quartz veins of Bridge River district, British Columbia, are described by W. S. McCann (*Econ. Geology*, 1922, **17**, 350). This district, which is about 100 miles north of Vancouver, on the eastern margin of the Coast Mountains of British Columbia, contains gold-quartz deposits which bear a striking resemblance, both in mineralisation and geological associations, to those of South-Eastern Alaska to the north, and Grass Valley, California, to the south; and this resemblance is suggestive of a common origin. The gold-quartz veins are associated with a stock of augite-diorite intrusive in rocks older than Lower Cretaceous. Gold occurs in the free state, and also intimately associated as a mechanical mixture with sulphides, especially arsenopyrite; it is also closely associated with tellurium minerals and with stibnite and chalcopyrite. Other sulphides occur in the veins in small quantities. The principal gangue is quartz, but calcite is of common occurrence.

It has been stated that the average extraction of gold by amalgamation from the ore of the King Vein of the Lorne mine has been $17 per ton, but samples collected by McCann from this vein assayed only about $6·5 per ton. The mining properties are still in the prospect stage except for a few small mines on Cadwallader Creek, which have been explored to a depth of 300 ft. Since the war little has been done in the district, but a revival of activity is anticipated in the near future.

The Goudreau gold area, Michipicoten District, Ontario, is described by Ellis Thomson (*Summ. Rept.*, 1921, *Geol.*

Survey, Canada, Part D, p. 17). Gold was discovered here in 1918, but the district was not recognised as of any importance until 1921. The gold-bearing area is about 17 miles south of Franz, where the Algoma Central and Hudson Bay and the Canadian Pacific railways meet. The country rock consists of acid and basic volcanic rocks (Keewatin), with some small intercalated bands of iron formation, intruded by a boss of granite. Dolerite dykes, younger than any of the above, are prevalent in this region.

Gold occurs in small quartz veins following the lines of schistosity of the Keewatin formations. The gangue of these "shear-veins" is quartz, with some calcite, and needles of black tourmaline are frequently present; pyrite, pyrrhotite and chalcopyrite also occur, but galena is rare. The veins are seldom more than a few inches wide, and rarely continue for more than a few feet in length. The second type of vein cuts across the schistosity of the rocks at various angles, and such veins are known as "cross-veins." The last type of vein is found only in the Murphy group, of which the main vein, on the Murphy claim, is of the fissure type, and strikes across the volcanic rocks in a general E.-W. direction, and dips S. 60° or is vertical. The width of this vein is from 1 to 10 ft., and it has been traced for a length of 800 ft. The country rock is mainly basic Keewatin. The gangue is quartz enclosing numerous small needles of tourmaline, which give it a black colour. Native gold, pyrrhotite and chalcopyrite occur together with some bornite, pyrite and blende. A band of iron carbonate formation runs parallel with, and occupies part of the same fissure as the vein. The Murphy claim appears to be the most promising in the district, and the only one where the vein has a regular gold content for more than a few feet. The workings are shallow at present.

United States.—The gold-bearing veins of the Round Mountain district, on the eastern flank of the Toquima Range, Nevada, are described by H. G. Ferguson (*Bull.* 725 I, 1921, *U.S. Geol. Survey*, p. 390).

The sedimentary rocks, of Palæozoic age, have been intruded by granite (age unknown), and Tertiary rhyolite appeared later. The Sunnyside mine contains several flat veins in the rhyolite. The most productive vein is Los Gazabo, which strikes E.-W., dips N. 15°, and has been worked to a depth of 300 ft. vertically. The ore for the most part consists of limonite and manganese oxide, enclosing free gold. On the 800-foot level, a little quartz and pyrite are present. The Keane vein dips S. 15° to 40°.

The ore commonly consists of drusy quartz carrying crystalline gold, and small amounts of alunite, pyrite and realgar. This vein meets Los Gazabo on the dip, but it is uncertain whether it continues in depth below the latter. The Mariposa vein is nearly horizontal near the surface, but dips S. 30° from the 700-foot level. Much quartz is present, but there has been later crushing and deposition of secondary gold. Other veins striking N.-W. and dipping steeply N.-E., have been mined to some extent. Moreover, there are a multitude of small vertical stringers, striking E.-W., rarely workable individually for any considerable distance, but sometimes so close together that they have been mined by the open-cut system. Elsewhere the stringers occur as steeply dipping fissures, which intersect one another at right angles, and these in turn are crossed by nearly horizontal veinlets. The three sets seem to follow joint-planes of the rhyolite.

In the Fairview mine, on a hill east of Round Mountain, closely spaced stringers of quartz, rich in free gold, occur in rhyolite, as well as a number of small fault-planes, which show much iron oxide, and are in places highly manganiferous, without quartz. In high-grade ore from the mine, the coarser quartz on the walls contains no gold, but the inner portion consists of very fine interlocking quartz grains, in which gold occurs as rather thick plates arranged in graphic texture. In veins of this type in many places the gold shows a distinct greenish tinge, in contrast to the yellow gold that is associated with limonites.

From 1910 to 1920 the Round Mountain Mining Co., working the Sunnyside mine, raised 341,834 tons of ore, the value of the bullion recovered therefrom being $2,267,500.

From 1906 to 1919, 8,693 tons of ore were milled from the Fairview mine, bullion being recovered to the value of $480,267.

The Wilshire gold mine, 25 miles S.E. of Laws, Inyo County, California, is described by H. W. Turner (*Eng. and Min. Journ.-Press*, November 18, 1922, p. 888). The mine is situated on the western slope of the Sierra Nevada, at an altitude of about 9,000 ft. The deposit occurs in a wide band of quartzite, striking E. 30° N. and dipping 60° N. 30° E., having granite on the hanging-wall, and quartz-monzonite on the foot-wall. The ore-body itself consists of about 13 ft. in thickness of this quartzite band, about 200 ft. from the hanging-wall (granite), and parallel both in strike and dip with, but having no fractures or selvages separating it from, the rest of the quartzite, so

that the gold contents can only be ascertained by assay. According to Adolph Knopf (quoted by Turner) there are sulphides disseminated in the quartzite which are principally pyrrhotite, but arsenopyrite, blende, chalcopyrite, pyrite and molybdenite also occur.

The mine is 300 ft. in depth, and drilling has proved that the ore extends 80 ft. below the second (bottom) level. Along the cross-cut at station 210, sampling shows a vein 20 ft. wide, of value $10·75 in gold per ton. An average of less than $8 per ton will not pay at present. From June 28, 1921, to February 1922, 12,357 tons yielded 4,621 oz. of gold and 721 oz. of silver.

The ore deposits of Gold Hill mine, at Quartzburg, Idaho, are described by A. J. McDermid (*Eng. and Min. Journ.-Press*, September 23, 1922, p. 537). This mine is the largest producer of gold in Idaho.

The Gold Hill vein, although now worked out, is considered to be the source of all the ore-bodies in the mine. It strikes N. 65° E., dips steeply S., is from 2 to 6 ft. wide, and is one of a system of fissures. The principal rock of the locality is an altered and fractured granite, which is intruded by dykes and chimneys of rhyolite-porphyry and diorite-porphyry trending E.-W., dipping N. 80°, and, on an average, 40 ft. wide. The vein cuts one of these rhyolite-porphyry dykes. Although fissures in the granite and diorite-porphyry sometimes yield ore, by far the greater quantity of it lies in the rhyolite-porphyry.

The ore-bodies being mined at present are in one of these dykes, about 300 ft. south of the Gold Hill vein. This ("Pioneer") dyke consists of quartz and felspar, the latter largely altered to sericite, with some cubes of secondary pyrite. It has been profoundly altered by hydrothermal action. The gold in the dyke occurs in small fissures up to 2 in. in width. The filling is chiefly quartz sprinkled with stibnite, having gold scattered through it in a finely divided state, and pyrite.

The mine has been developed to the 500-foot level. The shaft was recently sunk to the 600-foot level. The total extraction is from 90 to 95 per cent. The mine from 1864 to date has produced gold, containing a very small proportion of silver, to the value of $8,000,000.

Mexico.—Las Minitas-Baucarit gold belt, 25 miles from Navojoa, in Sonora, is described by Fernando Montijo H. (*Eng. and Min. Journ.-Press*, August 19, 1922, p. 323). A system of more or less parallel veins, striking in a general N.-S. direction, occurs both in hornblende-granite and newer

lava (? andesite), or in or near the contact between the two rocks. The main vein, which has been worked in La Junta and other lesser mines, strikes N.W., dips S.W. 70°, and is 29 ft. wide. At La Junta it is in the lava, a still younger lava (? andesitic) dyke forming the hanging-wall of the vein. The gangue, which is calcite, contains horses of country rock, but quartz is scarce. The first 6 ft. of the vein on the hanging-wall side averages about \$8 (U.S.) per ton in value (⅘ths of the value being gold and ⅕th silver); the rest of the vein has a value of about \$3 per ton. The calcite is stained with iron and manganese oxides; the gold, mostly invisible, is concentrated in specks of the iron oxide, but coarser gold, in visible grains, occurs along a seam in the vein less than ½ in. wide, close to, and more or less parallel with, the hanging-wall. Some wire gold in little bunches has been seen near the rich seam between the first and second levels of the mine. Some silver occurs as cerargyrite. The veins in the granite are more siliceous than those in the lava. At present the mines are shallow (La Junta is 220 ft. in depth), and are worked sporadically on a small scale.

Iron

Hungary.—According to a United States Consular Report (*U.S. Comm. Rept.*, No. 18, 1922), the reserves of iron-ore in the present State of Hungary amount to 5,650,000 metric tons, the remainder of the 144 million tons existing within the pre-war boundaries of the country having passed to Czecho-Slovakia.

An iron-ore deposit, estimated to contain from 30 to 40 per cent. of iron, was recently discovered at Eger, but owing to its small size it has not yet been developed.

The Hungarian Bureau of Mines state that the present supply of ore in Hungary will be exhausted in 10 years, and that the discovery of new and important deposits is improbable.

The deposits from which ore supplies are now drawn are in the northern section of the county of Borsod, about 160 miles from Budapest, near the Czecho-Slovakia border, and occupy an area of about 1·6 square miles.

Production of iron-ore in 1921 (suspended after July) amounted to 36,015 metric tons, whilst 33,429 tons were imported, mainly from Czecho-Slovakia.

Russia-in-Asia.—According to the *Engineer*, October 13, 1922, the Russian Geological Survey has compiled particulars of certain mining areas in Siberia, which have been published by the Soviet Government.

The Telbes iron-ore deposits, about 50 miles from Kuznetsk in Western Siberia, are connected by railway with the collieries in that area. They comprise nine separate ore bodies, of which three only have been explored. The actual ore reserve of this area according to recent investigations is estimated at 11 million tons and the potential reserve at 15 million tons. The ore contains from 60 to 63 per cent. of iron. The deposits lie about 200 ft. below the surface.

The Irbit and Abakan iron-ore deposits in the Yenisei River area have been only slightly examined. The reserves of these deposits are estimated at 8 million and 1½ million tons of ore respectively, carrying about 65 per cent. of iron. More detailed prospecting will doubtless result in large additions being made to these estimates.

Lead

Canada.—In *Summ. Rept.*, 1921, *Geol. Surv., Canada*, Part D, p. 71, F. J. Alcock describes the lead-zinc deposits of Lemieux township, Gaspe County, Quebec. These deposits are found in Devonian shales and limestones, which have been intruded by porphyry and syenite. The sedimentary rocks are folded, faulted, jointed and brecciated, and there has been movement during and since mineralisation. Owing to a thick overburden over a great part of the region, outcrops of the mineralised portions are few, and are usually indicated by galena fragments on the surface; in other cases veins are exposed, which consist of chambered quartz from which blende, and often galena, have been leached. The deposits take the form of veins, in some cases showing well-defined walls, but sometimes gradually merging into the country rock. Locally, horses of the country rocks are enclosed by these veins and thus a stockwork formation has been created.

The economic minerals are galena and blende in a gangue consisting mainly of quartz, but also containing minor quantities of dolomite, calcite and ankerite.

Sixteen veins have been exposed by surface workings, but exploration has been confined to a few of the more important veins and mainly to one vein. This vein has a known length of approximately 600 ft. and an average width of 8 ft. Locally it is much wider and there may be a border of mineralised breccia. Other veins, the lengths of which have not yet been determined, show even greater widths.

A composite sample of ore taken across 12 cuts of the principal vein contained lead 3·8 per cent. and zinc 7·9 per

cent., and generally the lead content of the veins and brecciated mineralised zones ranges up to 14 per cent. and the zinc content up to 15 per cent. The ore is simple in composition and easy to concentrate.

If the deposits continue in depth as seems not improbable they will be one of the largest lead-zinc deposits of America. At present, lack of communication is an obstacle to their development.

In *Canadian Mining Journal*, June 9, 1922, C. B. Dawson describes some zinc-lead deposits to the south of the Great Slave Lake in the North-West Territory. These deposits, which are 10 miles south of Pine Point on the south shore of the lake, were discovered in 1914, but were not examined in detail until 1920 and 1921, when the author and others carried out some stripping and test-pit sinking. The deposits are in a flat region consisting of rocks of Middle Devonian age, and those so far located occupy the eroded tops of anticlinal folds. The outcrops are characterised by the presence of sink-holes, which in some cases almost completely surround the ore-body and in general mark its surface limitations. Their maximum depth below the general level is about 20 ft. Where the deposits are capped either by barren or slightly mineralised dolomite or by boulder clay, the surface, apart from sink-holes, gives no indication of mineral deposits beneath. But at actual ore outcrops vegetation is absent and the surface is covered by a crumbly gossan in which are cubes of galena.

The ore minerals are galena and blende associated with marcasite and pyrite, but, so far down as they have been explored, oxidation has been observed.

The ore-bodies are found in irregular lenses or bunches, and also along bedding-planes, in the dolomite. The deposits appear to be roughly circular or elliptical in horizontal cross-section. Their depth is at present unknown, but is believed to be limited only by the thickness of the Presqu'ile dolomite, which, near the lake, is known to be about 200 ft. thick. The results of test workings indicate that there are nearly a million tons of ore. Assays of samples taken from all parts of the deposits show, on the average, 30 per cent. of lead and zinc, and 1½ oz. of silver per ton. Transport conditions are the only hindrance to the development of the deposits, but are being improved rapidly.

Mexico.—In *Mining and Metallurgy* (August 1922) is an abstract of a paper by S. F. Shaw on " Ore Deposits of

Sierra Mojada, Coahuila, Mexico," from which the following information is taken.

The Sierra Mojada mining district, at an altitude of about 5,000 ft., is in Western Coahuila about 5 miles east of the Chihuahua State Railway, and is at the terminus of the Mexican Northern Railway.

The ore deposits, the geology of which has been described in the *Imperial Institute Monograph on Silver Ores* (p. 94), may be classified into (1) oxidised argentiferous and ferruginous lead ore; (2) contact ore-bodies of various types; (3) silver impregnations in the limestone; and (4) oxidised zinc ore.

The first type occurs as a replacement of limestone along an E.-W. fracture zone, and also in a lesser degree as fracture filling, lying to the north of the main lead-ore body. The second type, the contact-ore bodies, are both copper-silver and lead-silver ores. They occur as replacements in the sheared limestone at or near its contact with the agglomerate.

No records of the early production are available, but the main ore-body, now practically exhausted, has yielded the greater part of the lead ore mined up to 1920, which has been estimated to amount from 3 to 3½ million tons. The deposits generally have also yielded large quantities of copper and silver ores. The value of the total mineral production from these deposits is believed to amount to between 50 and 75 million United States dollars.

A large tonnage of low-grade oxidised zinc-ore has been exposed, and, if a successful concentrating method can be applied, its exploitation may prove to be profitable.

Silver

England.—It is stated in the *Mining World* (April 8, 1922, p. 296) that the old Bodithiel mine, in the Glynn Valley, near Doublebois, Cornwall, was rediscovered quite recently, and is now being reopened. The mine is situated in a silver-lead district, which includes the Wheal Mary Anne and Wheal Ludcott mines, both of which, in the past, have yielded rich silver ore. The records of the Bodithiel mine are said to go back for two centuries, and 91,270 tons of silver ore raised contained 2,925,385 oz. of silver, which gives an average of about 32 oz. per ton. The Wheal Mary Anne mine contained, on an average, over 50 oz. of silver per ton. There are said to be two principal lodes, striking N.-S. and traceable for 1 mile. The high-grade ore (*i.e.* ore containing over 100 oz. of silver per ton) is being mined and broken for direct shipment to South Wales. Ore of

milling grade (say 20 oz. of silver per ton) will be treated by the minerals separation process.

Canada.—W. E. Cockfield writes on recent developments in Mayo district, Yukon (*Canadian Min. Journ.*, November 10, 1922, p. 766; cf. this BULLETIN, 1921, **19**, 425; 1922, **20**, 391). In 1922 three companies vigorously prospected their holdings in this district, and arrangements were made to handle 7,000 tons of argentiferous galena during the winter of 1922–23, or more than double the amount of ore shipped during the winter of 1921–22. The cost of transport is high. The ore is hauled 42 miles from the Stuart River, and is then transported on river steamers to the mouth of the Yukon, being subsequently transferred to ocean-going boats for shipment to smelters on the Pacific Coast.

The silver-lead deposits of Davidson Mountain, Mayo district, Yukon (cf. *Imperial Institute Monograph on Silver Ores*, p. 48), are described by W. E. Cockfield (*Summ. Rept.*, 1921, *Geol. Survey, Canada*, Part A, p. 1). The Davidson Mountains trend E.-W. for 30 miles, and are 12 miles wide. The formation consists of banded quartzite, quartz-mica schist, graphite-schist and crystalline limestone cut by dykes and sills of greenstone. The veins are fault-fissures, which have been filled with galena in a gangue of siderite and quartz, with which is associated manganite, and, in some cases, pyrite, chalcopyrite and blende. The ores resemble those of Keno Hill (cf. this BULLETIN, 1921, **19**, 425), but are much lower in their silver content and mineralisation. A sample of galena from the dump assayed: lead, 56·83 per cent., and silver, 76 oz. per ton.

United States.—The silver mining region of Talache, Idaho, is described by F. E. Wormser (*Eng. and Min. Journ.-Press*, September 30, 1922, p. 581). The Talache mine is situated about ¾ mile from Lake Pend Oreille, in a heavily wooded area. A tunnel was driven 3,500 ft. to cut the main silver vein on the 1,200-foot level. The vein strikes N. 10° E. and dips E. 30°–60°. The mine at present draws its entire output from the Little Joe vein, one of a series of parallel veins. The vein is narrow but persistent, and is roughly parallel to the bedding of the metamorphosed country rock. It is a typical fissure vein with a banded structure in many places. The country rock is either the St. Regis or some equivalent shaley quartzite of deep purple and green colour. The vein is traceable for half a mile on the surface, and, underground, has been developed

in a N.-S. direction for 1,700 ft. It varies up to 5 or 6 ft. in width. The average width is 16½ in., and the mean dip is 45°. The vein has been cut by normal faults, the displacements varying from 25 to 150 ft., and it is subject to rolls, slips, pinches and swells. There are small basic dykes in the mine, and granite rocks occur close to it, which attest the igneous origin of the deposition. The vein carries siderite, pyrite, chalcopyrite, blende, galena, arsenopyrite, tetrahedrite and quartz; and bornite, stibnite and hübnerite have also been identified. The silver is found chiefly in tetrahedrite, the content of the ore averaging from 12 to 20 oz. per ton.

Up to January 1, 1922, over 16,000 ft. of development was recorded, and the reserves were estimated to be 110,000 tons, carrying 0·09 oz. of gold and 17·5 oz. of silver per ton.

A paper by E. S. Bastin dealing with the native silver ores occurring near Wickenburg, Arizona, has recently appeared (*Bull.* 735*E*, *U.S. Geol. Survey*, 1922, p. 131). The ores of the Monte Cristo mine, near Wickenburg, occur as replacement veins in granite-gneiss, probably of pre-Cambrian age, intruded by dykes of pegmatite and dolerite. The age of the mineralisation may be late Tertiary. The principal vein strikes about N.-S., and dips about 50°. In 1913 it was developed by an inclined shaft with nine levels spaced approximately at 100-foot intervals. The vein varies from 1 to 15 ft. in width. The metallic minerals occur in bands or lenses a few inches wide, the intervening vein material carrying these only in sparsely disseminated grains. Assays of two samples of the chalcopyrite ore (the most prevalent ore) from the 8th level showed about 18 per cent. of copper, 36 oz. of silver and 4 dwts. of gold per ton. Some assays showed small amounts of nickel and cobalt. The rich silver ores of the mine, many of which carry niccolite, are largely restricted to a shoot which pitches S. 45°.

Mexico.—The ore-bodies of Santa Eulalia, Chihuahua, are briefly described in the *Monograph on Silver Ores* (p. 92). Some of the results obtained by recent mining and diamond drilling are given in detail by Harlan A. Walker (*Eng. and Min. Journ.-Press*, November 18, 1922, p. 896). In Santa Eulalia there are three types of ore, representing successive stages of formation, all of them occurring in irregular deposits in limestone (Cretaceous): (1) argentiferous pyrite, with an iron, alumina, silicate gangue; (2) replacement deposits of silver-lead-zinc ores in chimneys of circular and elliptical form, from 66 to

328 ft. in diameter, and with a maximum length of 656 ft.; this is the most important class of deposit, and includes the lead-silver carbonate ores mined by the El Potosi Mining Co.; (3) galena, carrying little silver and no gangue; this occurs in narrow streaks along fissures, and only certain isolated occurrences have proved of economic value.

Diamond drilling has been in use in the Santa Eulalia district for the last 19 years. By this method of testing, the ore-bodies have been proved, a large amount of valuable geological information has been obtained, and the drill-hole data have helped to determine methods of mining the ore-bodies. At present about 3,300 ft. of drilling is done every month on the properties of the El Potosi Mining Co. in Santa Eulalia.

Tin

Australia.—The Sardine Tin Mine, Oaky Creek district, Kangaroo Hills Mineral Field, Queensland, has been reported on by E. C. Saint-Smith (*Queensland Govt. Min. Journ.*, January 14, 1922, p. 5, and September 15, 1922, p. 350; cf. *Imperial Institute Monograph on Tin Ores*, 1919, p. 68). There is a wide lode formation or mineralised crushed zone or belt of altered slate and quartzite (? Upper Devonian) here, striking N.E.–S.W., and intruded by granite and quartz-porphyry (? Carboniferous). The ore occurs in large lenses practically contiguous with each other. The workings are about 250 ft. deep, measured on the dip of the lode. A rich lens of ore in the No. 4 South level has an average width of 4½ ft., and contains about 30 per cent. of coarse cassiterite. The ore-body has an easterly dip, but pitches S.S.W. 40°. It is being proved by a winze which was 70 ft. deep in July 1922. The ore won in this winze so far has been very free from copper or other minerals. In the No. 3 South level the ore, which is of uniformily high grade, has been stoped to a height of 5 ft. over a length of 80 ft., the average width being 2 ft. About 30 ft. to the west a new ore-body has been found, parallel to the main shoot, which produced 100 tons of ore with an average of 35 per cent. of cassiterite. Another form of ore has been exposed on the hanging-wall side of the No. 5 level, stated to be 18 in. wide and to contain 15 to 20 per cent. of cassiterite. Altogether 2,355 tons 4 cwts. of ore have been crushed from the Sardine Tin Mine, the yield being 582 tons 17½ cwts. of concentrate containing from 62 to 67·5 per cent. of tin.

Saint-Smith regards the Sardine property as one of the best high-grade tin mines in the Commonwealth.

The present prospects of tin mining in the Waratah district, Tasmania, are discussed by A. McIntosh Reid in *Chem. Eng. and Min. Rev.*, July 5, 1922, p. 319. At present none of the mines of the district is in active operation. At the Bischoff mines (cf. *Imperial Institute Monograph on Tin Ores*, 1919, p. 71), a little development work is being carried on, and one unit of the milling plant is employed in the re-treatment of the pyrite concentrate after its calcination. On Pryda's section in the same area exploratory work has been attended with encouraging results.

Three main types of deposits occur in the Waratah district, namely: (1) fissure veins, (2) replacement deposits, (3) aplite dykes. The fissure veins are narrow, rich and remarkably persistent both in length and depth. The replacement deposits, which constitute the chief sources of tin ore at the Bischoff mine, are large, irregularly shaped, pyritic masses containing occasional rich bunches of tin ore. The masses extend to a depth of 300 ft., but rich tabular ore-bodies are found beneath the pyrite deposits. In 1920 rich ore was intersected in the residual deposit known as the Brown Face (Bischoff mine) between the open cut and main tunnel. Unfortunately, attempts to mine this ore failed, owing to the spontaneous ignition of the sulphidic ores. Reid has recommended that the overburden should be quarried and milled for its sulphur content, the free cassiterite being obtained as a by-product. This plan of operation, which will provide also a profitable means of exploring the large pyrite masses in and near the White Face and elsewhere, is likely to be adopted.

The ore-bodies in the South Bischoff area are contained in aplite dykes, in which cassiterite is rather irregularly distributed in the form of short lenses, and are associated invariably with fluorine-bearing micas, which may be regarded as the indicators of the ore.

Uranium

Canada.—A detailed account of the nature and extent of the radium-bearing pegmatites of Ontario is given by H. V. Ellsworth in *Summ. Rept.*, 1921, *Geol. Survey, Canada*, Part D, p. 51. All the radium-bearing minerals so far found in Ontario have been located in the area of pre-Cambrian rocks, south of French and Ottawa rivers and west of a line drawn between Ottawa and Kingston. Pegmatites occur in dykes and intrusions of varying sizes; most of them are of the granite type and consist mainly of potash- and potash-soda-felspars with quartz and other

accessory minerals. It is in such dykes that the minerals uraninite, euxenite-polycrase and allanite have been found in Ontario. As a general rule the felspar is coloured red in the vicinity of uranium minerals. Descriptions are given of the occurrence of these minerals in the neighbourhood of the Parry Sound, Butt township, Craigmont, Maberly, Opeongo Lake and Aylen Lake districts. As a general rule the radio-active minerals occur in a widely disseminated condition and it is considered unlikely that rich concentrations will be found in occurrences of the type described above. It is suggested that the recovery of the radio-active minerals might be carried on as a process subsidiary to the production of ground felspar.

United States.—Asphaltites carrying vanadium are well known, but the occurrence of uranium in this type of mineral is rare, and hence the account of the uranium-bearing asphaltite sediments of Utah, given by F. L. Hess in *Eng. and Min. Journ.-Press*, August 12, 1922, p. 272, is of special interest.

The deposits in which this mineral is found occur on Temple Mountain, about 45 miles south-west of the town of Greenriver, and in adjacent localities on the eastern flank of the San Rafael Swell in S.E. Utah.

San Rafael Swell is an oval dome, 40 miles long and 20 to 30 miles broad. In most places, the Jurassic sandstones, which formed its summit, have been eroded, but these remain at Temple Mountain, which rises 700 ft. above the general level. The lower part of this mountain is composed of the Moenkopi (Lower Triassic) red beds, overlain by 60 ft. of conglomerate, the sandy portion of which contains lenticular masses of uranium-bearing asphalt, often carrying vanadium also.

The lenticular masses vary considerably in size and in their content of the metals. Thus in some places they measure 100 ft. by 20 ft. by 7 ft., and in others they are as small as 3 ft. by 4 ft. by 6 ft.

Analyses quoted for certain samples show the asphalt to contain from 2·1 to 4·6 per cent. of uranium oxide (U_3O_8), and from 0·4 to 2·1 per cent. of vanadium oxide (V_2O_5), but it is stated that a considerable tonnage of ore was shipped during the war, with an average of 1·75 per cent. of uranium oxide and 4 per cent. of vanadium oxide.

Zinc

Canada.—Reference to the lead-zinc deposits of Lemieux township, Quebec, is made in the section on lead (p. 545) and to those south of the Great Slave Lake in the North-West Territory on p. 546.

NOTICES OF RECENT LITERATURE

British North Borneo. An Account of its History, Resources and Native Tribes. By Owen Rutter. Pp. xvi + 404, 8vo, 9 × 6. (London: Constable and Co., 1922.) Price 21s.

Readers desiring a fuller and more generalised account of British North Borneo than that given in the official handbook recently issued (see this Bulletin, 1922, **20**, 265) will find it in Mr. Rutter's comprehensive work. Sir West Ridgeway, President of the British North Borneo Chartered Company, has contributed a short Introduction, in which he commends the book to the public, and mentions the high qualifications of the author for writing an account of the country; he points out that Mr. Rutter has an intimate acquaintance with North Borneo due to his career there, first as a Government officer and subsequently as a planter.

This wide knowledge of his subject is evident in every chapter of Mr. Rutter's book, and though he readily acknowledges his indebtedness to various authorities for much of the information he furnishes, it has been his part to present it in a clear and attractive manner. The geography, history, ethnology, folklore and administration of the country are dealt with in different chapters, whilst the scenery, forest and mineral resources, agriculture and general development of the territory also have their proper place in the work. Readers can therefore turn at once to any section likely to be of special interest, but it is safe to say that many will decide to read through the volume from cover to cover when they have discovered Mr. Rutter's concise and graphic style. Some may find the romantic history of the country during the last eighty years the most interesting part of the book; whilst others will specially appreciate the author's description of the jungles and forests, which cover so much of the Protectorate and provide such a large part of its natural wealth; the entertaining chapter on "Travel"; or the accounts of rubber, tobacco, coconut and coffee cultivation, and other aspects of human enterprise.

Among crops little cultivated at present, or not cultivated at all, but which Mr. Rutter considers worthy of encouragement, are Sisal hemp, cotton, tea, cocoa, sugar-cane, sago palms and castor seed; whilst there is evidently room for improvement in the methods of collection of some of the wild products of the country.

Many will be particularly attracted by that part of the book which describes the various races and tribes which

compose the limited native population, and the influence and importance of the Chinese and other immigrants on whom the prosperity of the territory so largely depends. Sir West Ridgeway remarks: " Forty years ago the country was a tropical wilderness; untilled, uncared for, utterly neglected. To-day it is the scene of patient toil and industry. . . . It is still in its youth as a producing country, and the next few decades will assuredly witness an immense expansion of its industrial activities." A perusal of Mr. Rutter's pages makes it clear that if this development does not in fact occur, it will be owing to an insufficient supply of capital or labour and not to any lack of inherent resources.

The book is embellished with a number of illustrations from photographs and an excellent map, as well as a bibliography, statistics of imports, exports, revenue and expenditure, and a comparative table giving twenty-five common words in the principal native languages and dialects.

THE HANDBOOK OF PALESTINE. Edited by Harry Charles Luke, B.Litt., M.A., and Edward Keith-Roach. Pp. x + 290, 8vo, $7\frac{1}{2} \times 5$. (London: Macmillan & Co., Ltd., 1922.) Price 12*s*.

This is a practical and comprehensive handbook, compiled by two responsible officers of the Palestine Government and issued under its authority. The work gives concise and interesting descriptions of the geography, history, ethnology and religious institutions of the country, whilst sections are also devoted to its archæology and art, topography, travelling facilities, agriculture, climate, administration, education, fiscal arrangements, geology, fauna and flora, and a number of other subjects. The League of Nations Mandate for Palestine is given as an appendix, and a useful map of the country is supplied.

The appeal of the various sections to individual readers will naturally depend upon personal tastes and interests. Those concerned with the general economic conditions of the country and its agricultural and industrial problems will find these matters adequately dealt with, whilst naturalists will appreciate the systematically arranged information relating to their special subjects.

An instructive account is given of the geological history and present mineral resources of the country, and it may be of interest to mention here that, in addition to the occurrence of bituminous limestone and sandstone in various districts, " it is generally agreed that sunken blocks of the Ghor are petroleum-bearing, and that oil will be

obtained by drilling into the Senonian-Turonian beds." A well-known company is now prospecting for oil in the area round Kharnub and is stated to be optimistic as to the results.

The remarkable characters of the Jordan Valley are treated at considerable length, and its great scientific interest is clearly demonstrated. The volcanic nature of the region is emphasised, and it is stated that " Faulting of the Dead Sea deposits and the earthquakes which still occasionally disturb the district give warning that the fissuring and faulting and deepening of the Ghor may still be proceeding, and that its dark sides may once more glow with streams of molten lava." From an economic standpoint the most important feature of the valley is the Dead Sea (the surface of which is 1,350 feet below sea level), which contains 25 per cent. of salts, including a considerable proportion of potassium chloride. It is estimated that the Dead Sea area holds some 30,000 million tons of mixed salts, of which 1,500 million tons may consist of potassium chloride, so that when the district is opened up commercially it should prove to be an extremely valuable source of crude potash. It is also suggested that among other industries the electrolytic production of alkalis may eventually be feasible.

The High Commissioner for Palestine, Sir Herbert Samuel, has contributed a short introduction in which he describes the handbook as " accurate and readable." The book is carefully written and clearly arranged throughout, and the technical information it contains has been contributed by Government officers and other qualified experts. The general scheme of the work is on the lines of *The Handbook of Cyprus*, of which also Mr. Luke was joint author. The new volume undoubtedly forms one of the most practical and instructive handbooks so far issued. It may however be suggested that the next edition should if possible be sold at a lower price, so as to reach a wider public and thus enhance the usefulness of the volume.

ENVIRONMENTAL INFLUENCES AFFECTING BLONDES IN RHODESIA AND THEIR BEARING ON THE FUTURE. A Survey of the Situation from the Medical and Scientific Standpoints. By Dr. W. M. Hewetson. Pp. 27, 8vo, 8½ × 5½. (Salisbury, S.R.: The Rhodesia Independent Co., Ltd.; London: Simpkin, Marshall, Hamilton, Kent & Co., Ltd., 1922.) Price 2*s*. 6*d*.

This pamphlet consists of a paper delivered before the Rhodesia Scientific Association at Salisbury on May 15,

1922. The author uses the word "blondes" to express the races usually referred to as "whites." He points out that Rhodesia lies wholly within the tropics and emphasises the fact that if the Rhodesian settlers succeed in establishing themselves as a permanent self-governing community, they will be the first blondes in the history of the world to have achieved such a position in a wholly tropical country.

The possibility of this aim being realised and the factors bearing on the problem are discussed. With regard to population, consideration is given to questions of immigration and the birth-rate among blondes in Rhodesia, and this leads to a recognition of the fact that the country is beyond the natural range of the blonde races.

The author then enquires more particularly into the causes of the difficulty experienced by Europeans in colonising the tropics and deals at some length with the effects of the tropical sunshine. Blondes lack the protection against the influence of the actinic rays which is possessed by the natives in virtue of the pigmentation of their skin. Attention is drawn to the custom of living in low-roofed houses with corrugated iron roofs and the author expresses some very severe strictures on this practice.

In conclusion, it is recommended (1) that houses should be so constructed that it may be possible to sleep practically in the open air when the weather is fine, (2) that the living rooms should be some distance from the earth, by the provision of a second story or some other means, (3) that the roof should be composed of material which is a non-conductor of heat, (4) that grass should be grown round the houses and the streets shaded with trees, and (5) that suitable spectacles should be used to keep excess of light and actinic rays from the eyes and that non-actinic clothing should be worn, especially by those who have to work in the open.

The pamphlet is written in a somewhat unconventional style, but is of considerable interest, as it deals with problems of great importance in relation to the development of European colonies in tropical countries.

Researches on Cellulose, IV (1910–1921). By Charles F. Cross and Charles Dorée. Pp. x + 253, 8vo, 7¾ × 5¼. (London: Longmans, Green & Co., 1922.) Price 15*s*.

This book forms the fourth volume of the "Cross and Bevan" series on cellulose. The change in the author-

ship is due to the death of Mr. Edward J. Bevan, who for forty years took an active part in the researches on which the previous volumes were founded.

The new volume reviews critically the progress made during a period of great scientific development, including the concentrated activity occasioned by the war. An account is given of all the more important investigations in this field of discovery during the period, the researches being divided into several classes, dealing respectively with the physical properties and relationships of the celluloses, their chemical constitution, the conception of cellulose as an organic complex, the transformation products of cellulose known as oxycelluloses and hydrocelluloses and their characteristic component referred to as lignin or lignone, and the cellulose industries and technology.

The subjects reviewed under the last-named heading will probably be of the greatest interest to readers of this BULLETIN. They include the industrial utilisation of cotton linters (cf. this BULLETIN, 1921, **19**, 528), the use of wood-pulp cellulose for the manufacture of nitrocellulose explosives, the value of bamboos, papyrus and other materials for paper-making, the production of paper yarns for the manufacture of textiles (cf. this BULLETIN, 1918, **16**, 515), the employment of kapok as a filling material for marine life-saving appliances, and other technical developments.

Special attention is devoted to the product which has recently been widely referred to in the press under the name of "Arghan fibre" and the results of tensile tests are recorded. As much interest has been aroused in this fibre, it may be well to quote the following statements which appear on pages 212–213 of the book:

"Arghan fibre is a new raw material claiming attention and study by reason of exceptional characteristics, and also on the ground of potential industrial commercial development. The fibre is a leaf-fibre of a monocotyledon which is stated to be one of the *Bromeliaceæ*. The plant, as a fibre-yielding plant, 'discovered' in South America, has been transplanted to the Malay Peninsula for cultivation: and capital has been found for development to the stage of establishing the fundamental elements of technical and industrial value, viz. tensile qualities of the fibre, including resistance to sea water, and high, cultural yields as a crop product, the leaf yielding 20 per cent. of fibre and the plant having a free growth which ensures easy cultivation and high yields per acre. . . . It has to be stated that the specimens so far supplied for industrial working have been obtained by hand-dressing process: there has been no

systematic selection of leaves, and no systematic study to determine the optimum of growth condition, nor of treatment incidental to the separation of the fibre strands."

The book contains a number of illustrations, and indexes of both authors and subjects. This and the earlier volumes of "Researches on Cellulose" serve a useful purpose in providing a ready means of obtaining knowledge of progress in this branch of chemistry and chemical technology, and are consequently of considerable value to those interested in cellulose and its industrial applications.

An Introduction to the Chemistry of Plant Products. Vol. II. Metabolic Processes. By Paul Haas, D.Sc., Ph.D., and T. G. Hill, A.R.C.S., F.L.S. Pp. viii + 140, 8vo, 9 × 6. (London: Longmans, Green & Co., 1922.) Price 7*s*. 6*d*.

The first volume of this work, dealing with the chemical problems relating to the commoner organic substances occurring in plants, has already been noticed in this Bulletin (1920, **18**, 570).

The second volume, which has recently appeared, deals with the metabolic processes of the living plant, and contains chapters on the synthesis of fats, carbohydrates and proteins, the chemistry of the respiratory functions, including all those processes which involve a liberation of energy employable by the organism in its various activities, and an account of the anabolic and catabolic changes on which the growth and development of the plant depend.

The book is written in an interesting manner and can be recommended as a useful textbook for students of vegetable physiology.

The Chemistry and Technology of Gelatin and Glue. By Robert Herman Bogue, M.S., Ph.D., Industrial Fellow of the Mellon Institute of Industrial Research of the University of Pittsburgh, and Research Chemist for Armour and Company of Chicago. Pp. xi + 644, 8vo, 9 × 6. (New York and London: McGraw-Hill Book Co., Inc., 1922.) Price 30*s*.

There are few publications which deal at all fully with the chemistry, manufacture, testing, analysis and general applications of gelatin and glue, and this new volume will therefore be of much value to students and others who desire to become acquainted with the principles which underlie the industries connected with the preparation and utilisation of these materials. The object of the work is

indicated in the preface by the statement that "the attempt is made throughout the book to attack the subject from the point of view of the chemist rather than from that of the plant technologist, and it is primarily for the student and investigator—the thinkers ahead—that the book is written."

The book is divided into two parts, dealing respectively with the theoretical and technological aspects of the subject. The first part discusses the constitution of the proteins, the chemistry of gelatin and its congeners, the physico-chemical properties and structure of gelatin, and the behaviour of gelatin as a lyophilic colloid and as an amphoteric colloid.

The second part of the work is of a more practical nature. It contains a chapter on the manufacture of glue and gelatin, contributed by Ralph C. Shuey, M.S., who is now engaged as chemical engineer with the Redmanol Chemical Products Co. of Chicago and was formerly with the Armour Glue Works of Chicago, and is therefore well qualified to deal with the subject. Another chapter is concerned with water-resistant glues (casein and blood-albumin glues) and with glues of marine origin (including isinglass and liquid fish glue), the portion relating to the liquid fish glue being written by Donald K. Tressler, Ph.D., of the Mellon Institute of Industrial Research, Pittsburgh University. Other chapters treat of the testing of glue and gelatin, their chemical analysis, detection and estimation, their evaluation, and their uses and applications.

A number of useful tables are appended, and both subject and author indexes are provided. The book is well written and contains a number of excellent diagrams.

THE ELECTRO-METALLURGY OF STEEL. By C. C. Gow, B.Sc., A.R.S.M. Pp. xvi + 351, 8vo, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Constable & Co., 1921.) Price 27*s*. 6*d*.

The electro-metallurgy of steel on an industrial scale has only attained importance in this country during the past few years and in view of this recent development the present volume is particularly welcome.

About one-third of the book is devoted to the electrical side of the subject. Useful chapters follow on liquid steel refining, ingot casting and foundry work. A brief *résumé* is given of the principles of electric furnace design, together with a good account of modern types of electric steel furnace and the refractories used in their construction. The book contains numerous diagrams and concludes with a concise description of methods for the rapid chemical

analysis of samples of steel taken during the course of manufacture.

A HANDBOOK OF PETROLEUM, ASPHALT AND NATURAL GAS. By Roy Cross. *Bulletin* 16, *Kansas City Testing Laboratory*. Pp. 622, 8vo, $7\frac{3}{4} \times 6$. (Kansas City, Mo., U.S.A.: Kansas City Testing Laboratory, 1922.) Price $7·50.

This volume gives in a concise form a useful collection of information relating to the production, properties, handling, refining, analysis and uses of petroleum and allied products.

It is difficult in a short notice to convey an adequate idea of the many subjects dealt with in the book, but as illustrating its wide scope, mention may be made of some sections of special interest to the chemist. These include detailed methods of analysis and specifications for all varieties of petroleum products, an account of the physical properties of crude oils now being obtained from the more important producing localities, the composition of many commercial gasolines, and a method for calculating the probable yield of gasoline obtainable from the several types of crude petroleum.

Many tables of constants of general interest to the engineer are also given, and the usefulness of the work is enhanced by the provision of numerous diagrams and a good index.

COAL: ITS PROPERTIES, ANALYSIS, CLASSIFICATION, GEOLOGY, EXTRACTION, USES AND DISTRIBUTION. By Elwood S. Moore, M.A., Ph.D., Professor of Geology and Mineralogy and Dean of the School of Mines in the Pennsylvania State College. Pp. 462, 8vo, 9×6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1922.) Price 25s.

The object of this work is to present a handy summary of the voluminous literature on coal. The earlier chapters deal with the physical and chemical properties, varieties and classification of coal. Under the last-named heading about a dozen proposed systems of classification are given, of which a few can be used for certain regions with satisfactory results but none can be regarded as of universal application. In the chapter on the origin of coal, the *in situ* and drift theories are fairly stated and the development of peat in bogs, marshes and swamps is well explained, and it is pointed out that "We seem to have abundant evidence of the efficiency of fresh-water swamps in produc-

ing coal deposits under proper climatic and topographic conditions." The biochemical stages in the transformation of vegetable matter into coal are discussed, and the rôle played by bacteria, fungi and other lowly organisms in producing chemical changes and aiding in the maceration of the plant débris is explained. The various factors in the dynamochemical stages, such as length of time since burial, depth of burial and effect of pressure are treated clearly and concisely. In the author's opinion, "the best hypothesis so far offered for the origin of anthracite and the one which it is believed will explain its origin in all the fields so far studied if logically applied, is the thrust-pressure hypothesis."

One chapter is devoted to the fossil flora of the coal-forming periods, and is illustrated by excellent figures taken from Zeiller, Grand'Eury, and other authorities.

The chapters dealing with the classification and valuation of coal lands, coal mining, and the preparation and uses of coal refer largely to American practice. The room-and-pillar method of mining bituminous coals and anthracite are well described and illustrated. The long-wall method is comparatively little used in the United States, but a modification, known as the block long-wall system, is practised in the anthracite region of Pennsylvania, and the plan of it shown in the text is admirably drawn, rendering a detailed description unnecessary. The coal-fields of the world are briefly described in the last three chapters of the work, several of the maps, and most of the text being based on *The Coal Resources of the World* (Twelfth International Geological Congress, Canada, 1913).

On the whole the work may be regarded as an excellent and comprehensive handbook. The text is well written, and the illustrations are numerous and clear.

COAL: A SERIES OF LECTURES ON COAL AND ITS UTILISATION. By H. Chamberlain, J. W. Cobb, R. Lessing, F. S. Sinnatt and M. C. Stopes. The University of Sheffield Department of Fuel Technology. Pp. 41, 4to, 11¼ × 8½. (London: Colliery Guardian Co., Ltd.) Price 5s.

The first lecture, on the constitution of coal from palæobotanical aspects by Dr. Marie Stopes, deals principally with the origin and physical properties of fusain, durain, clarain, and vitrain (see this BULLETIN, 1921, **19**, 91, and 1922, **20**, 115). Dr. Stopes has revived the old name "ulmins" for the highly complex colloidal jelly which originates when the softer portion of plants reaches a certain stage

of decay, as she considers it preferable to "humic acid." The chemical qualities of the four different ingredients of bituminous coal are now being investigated by research students in the University of Sheffield.

The second lecture, by F. S. Sinnatt, is on the preparation of coal for the market. The grading of coal, the purification of coal by means of the spiral separator, and of fine material by the froth flotation process are the chief points of interest.

The third lecture, on the carbonisation of coal, is by R. Lessing. The results obtained by Tideswell and Wheeler on the vacuum distillation of fusain, durain, clarain and vitrain by raising the temperature by stages from 300° C. to 600° C. are shown in charts. With regard to low temperature carbonisation, it is pointed out that its technique should be so perfected that it will enable an industry founded upon it to stand alone, and neither be dependent on, nor interfere with, the existing interests. The last two lectures on the purification of coal gas by Horace Chamberlain, and ammonia from coal by John W. Cobb, will prove of interest to students of applied chemistry.

BUSINESS GEOGRAPHY. By Ellsworth Huntingdon and Frank S. Williams. Pp. x + 482, 8vo, $8\frac{1}{2} \times 5\frac{1}{2}$. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1922.) Price 13*s*. 6*d*. net.

This volume is stated to occupy an intermediate position between two books by Huntingdon and Cushing entitled, *Commercial and Industrial Geography*, and *Principles of Human Geography*, the latter of which has been noticed in this BULLETIN (1921, **19**, 267). Business geography is viewed by the authors as comprising a study of the products and needs of various communities, conditions of transportation, and the character of the people. In their opinion, the character of the people counts for far more in determining the part played by a country in commerce than either their number or the natural resources, and this subject is therefore more prominent than usual in textbooks on geography.

The first part of the work is concerned with general principles, and the effect of specific geographical factors on trade is clearly and concisely explained. The two chapters on transport and sources of power are exceedingly good, but, in view of the numerous difficult problems yet to be solved, there seems little prospect in the near future of "great types of tropical plantations devoted to raising rapidly growing plants for alcohol, and great fortunes

being soon made by installing alcohol plants on so large a scale that the product can be sold everywhere in competition with gasoline." As population and needs increase, new sources of food and raw material will undoubtedly be required, but the authors seem unduly pessimistic in their estimates of the extent of the natural resources of the world. Nevertheless, their observations regarding the imperative need for measures of conservation and their suggestions for the further development of rugged regions and of the large supplies of food available in the sea merit serious consideration.

Part II contains a description of different "business communities" classified under seven groups of occupations, and of the geographical factors on which their location depends. In the somewhat brief account of tropical agriculture which is included here it is indicated that with the exception of sugar, bananas, cotton, Sisal hemp, Manila hemp, quinine and rubber, none of the tropical plantation products is of real importance to the well-being of mankind.

Europe, Asia, India and the Far East, Africa, Australia, Latin America, and the United States and Canada are next examined in turn, and the distribution of the various types of "business community" and the influence of geographical conditions on the capacity of the people and on the products are discussed in each case. As might have been expected, the description of geographical conditions in the United States of America is considerably more detailed than that of other parts of the world; but in view of the important trade between Canada and the United States more attention might well have been paid to the Dominion, although the "well-inhabited part of that country" is regarded as "merely a northern extension of the United States" and is treated as such. It is also to be hoped that in a future edition it will be possible to allocate more than a few lines to the West Indies. The principal problems affecting the development and value of British possessions in Africa, Australia and the East are, however, dealt with adequately, and among other important questions treated in an interesting manner are the influence of political and commercial control in China in determining the course of the world's future trade, and the effect of the war on European commerce. Readers in this country will be pleased to find that American writers predict that within a few decades or a generation or two Great Britain's share of the world trade will be nearly the same as if there had been no war.

In the opinion of the authors the comparatively small

part played by Africa and South America in the world's commerce is mainly due to the fact that superior tropical labour is available elsewhere. Although the value of the imports of the United States of America from tropical Africa rose from £4,300,000 in 1913–14 to £16,300,000 in 1921 this sum only represented 0·6 per cent. of the total value of the tropical products imported in that year. The difficult questions connected with the position of Europeans in India are not held to be of any great importance so far as America is concerned, as less than one-sixth of India's trade is with the United States of America; nevertheless, the exports from India in 1921 were as much as the total from the four South American republics of Argentina, Uruguay, Paraguay and Bolivia.

In the otherwise admirable comparison of the commerce of different parts of the world, sufficient recognition has not been given to the fact that the relative positions of different regions in the production of a commodity cannot always be judged accurately by their output or by its value, as the product from one region, although limited in quantity, frequently possesses special features which render it particularly suitable for certain industrial purposes.

Part IV concludes with an excellent survey of the trade of the United States and Canada with other parts of the world and of the causes of the changes which are taking place. Trade with Europe is falling off, but is still the most important, whilst that with Asia and Oceania is increasing, but there is a more marked increase in the case of neighbouring countries. At the present time the principal difficulty connected with American commerce is how to make the mercantile marine pay whilst maintaining American rates of wages.

The work under review is commendably free from loose generalisations, and practically all the conclusions drawn are supported by statistics, the collection of which has obviously entailed very exhaustive research; but unfortunately their usefulness has been impaired by the frequent omission to indicate their source and in some cases the year to which they refer. Figures relating to the period of the war have wisely not been included owing to the abnormal conditions prevailing; but, as in many instances data relating to pre-war years only have been available, a revised edition of the book will shortly be needed if its utility for reference purposes is to be maintained.

The book contains a number of excellent maps and diagrams and, on the whole, appears to have been carefully compiled and will undoubtedly fulfil the purpose for which it was specially prepared, viz. a textbook for American

students in schools of commerce and in commercial departments of colleges. Although written from the American standpoint it contains much of general interest to students of economic problems, and should also appeal to all who are contemplating taking up a commercial career or are already engaged in commerce and industry, for whom a thorough knowledge of geographical principles is invaluable.

The Practical Applications of X-rays. By G. W. C. Kaye, O.B.E., M.A., D.Sc., A.R.C.Sc., F.Inst.P., Head of the Radiology Department, the National Physical Laboratory, and Past President of the Röntgen Society. Pp. viii + 135, 8vo, $8\frac{1}{4} \times 5\frac{3}{4}$. (London: Chapman & Hall, Ltd., 1922.) Price 10*s.* 6*d.*

The X-rays, which constitute one of the most remarkable discoveries of modern science, were unknown until 1895, when Professor Röntgen first detected them by means of a Crookes' tube. The fact that our acquaintance with the rays is of such recent date is apt to be lost sight of in view of the present important position which they occupy in physics and in medicine and the wonderful variety of directions in which they have been applied.

The present work, which is largely based on a course of Cantor Lectures delivered by the author before the Royal Society of Arts in 1921, gives a concise but clear account of the X-rays and their practical applications.

The nature of the rays and their relation to other forms of radiation are discussed, and the methods of their generation and measurement are carefully described.

The medical applications of the rays are briefly dealt with, and it is pointed out that they have given the diagnostic methods of the physician and surgeon a facility and exactitude which would formerly have been regarded as almost incredible.

The industrial uses of X-rays in the examination of materials are recorded, their employment for this purpose lying at present in two main directions, viz. (1) X-ray spectrometry, or the study of crystal structure, and (2) radiography, or X-ray shadow photography.

It is indicated that the former method enables the presence of impurities in materials to be demonstrated much as in optical spectrometry, and it is suggested that the metallurgist may find that it will throw light on the fundamental nature of the effect of heat-treatment, tempering, rolling and ageing on crystalline metals and alloys.

Numerous applications of the radiographic method are described, among which the following may be mentioned. The examination of metals and alloys for the presence of hidden cracks, blow-holes, defective soldering, brazing and welding, and for the detection of hidden corrosion and other defects; and the examination of such various products as explosives and ammunition, timbers (especially in aeroplane construction), rubber, optical glass, and electric insulators.

As further illustrating the diversity of the uses of the X-rays, reference is made to the examination of oysters for pearls; the differentiation of lead-glass jewels from genuine gems; the scrutiny of artificial teeth; the detection of contraband by the customs officials; the inspection of the workmanship in hair brushes and tooth brushes; the sorting of fresh from stale eggs; the determination of the degree of thoroughness with which the ingredients of powders have been mixed; the detection of heavy elements in minerals, of weevils in grain, of mineral adulterants in powdered drugs, and of moths in tobacco; the measurement of the internal diameters of tubes of metal or glass; the examination of mummies for the purpose of ascertaining their contents, and the examination of leather in boot factories; the application of the rays in scientific work, as in examining the interior of shells and fossils and studying the internal structure of plants; and in the determination of the genuineness or otherwise of oil paintings or in detecting alterations to old pictures.

The book is furnished with a wealth of excellent illustrations and diagrams, and contains three appendixes, viz. (1) the reports of the X-ray and Radium Protection Committee, (2) a glossary of terms used in X-ray and electro-medical work, and (3) a list of the chemical elements arranged in order of the atomic numbers.

The work is written in an interesting manner and can be recommended as a useful introduction to the study of the X-rays.

Marine Works: a Practical Treatise for Maritime Engineers, Landowners and Public Authorities. By Ernest Latham, M.Inst.C.E., etc., With a Preface by C. le Maistre, C.B.E., A.M.Inst.C.E., M.I.E.E. Pp. viii + 174, 8vo, $8\frac{3}{4} \times 5\frac{3}{4}$. (London: Crosby Lockwood & Son, 1922.) Price 16s.

This work describes the formation, action and effect of waves, the salvage of maritime works, the maintenance of tidal berths, pile-driving, the conservancy of marsh lands,

coast defence, structural problems on navigable rivers, scour, and deep-water quays. Of special interest to engineers is the portion of the work dealing with hydro-electric problems, including the proposed installation for utilising the tides at Mersea Island, Essex, which is illustrated by plan and diagram. Stress is laid on the advantages of short concrete groynes of the weir type over the old-fashioned groyne so familiar at most seaside resorts, and on the usefulness of timber as compared with reinforced concrete in the construction of deep-water quays as, in case of damage by collisions, the extent of the damage is clear and defined and the damaged work can rapidly be dismantled, which is not the case with reinforced concrete.

The work is clearly written, is well illustrated, and should prove indispensable to maritime engineers and others, who have to deal with certain sea and coastal problems.

BOOKS RECEIVED

Flavouring Materials, Natural and Synthetic. By A. Clarke, F.C.S. Pp. xiv + 166, 8vo, 7½ × 5. (London: Henry Frowde and Hodder & Stoughton, 1922.) Price 8*s*. 6*d*.

The Textile Recorder Year Book—1923. Pp. xcv + 712, 8vo, 7½ × 5¼. (Manchester and London: John Heywood, Ltd., 1923.) Price 7*s*. 6*d*.

Colour Index. Edited by F. M. Rowe, D.Sc., F.I.C. Part I. Pp. 24, 4to, 12¼ × 10. (Bradford: Society of Dyers and Colourists, 1922.) Price of complete work (12 parts) £4 4*s*.

Civil Engineering Geology. By Cyril S. Fox, B.Sc., M.I.M.E., F.G.S. Pp. xvi + 144, 8vo, 10 × 6¼. (London: Crosby Lockwood & Son, 1923.) Price 18*s*.

Cements and Artificial Stone: A Descriptive Catalogue of the Specimens in the Sedgwick Museum, Cambridge. By the late John Watson, Hon. M.A. (Cantab.), F.G.S. Edited by R. H. Rastall, Sc.D., M.Inst.M.M. Pp. xii + 131, 8vo, 7½ × 5. (Cambridge: W. Heffer & Sons, Ltd., 1922.) Price 6*s*.

A HANDBOOK OF THE PETROLEUM INDUSTRY. By David T. Day, Ph.D. In two volumes. Vol. I, Pp. x + 964; Vol. II, Pp. vi + 1006, 8vo, 9¼ × 6¼. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Limited, 1922.) Price 75*s*.

OIL POWER. By Sydney H. North, Assoc. Inst.P.T. Pp. ix + 122, 8vo, 7¼ × 5. (London: Sir Isaac Pitman & Sons, Ltd.) Price 3*s*.

MODERN GASWORKS CHEMISTRY. By Geoffrey Weyman, D.Sc., F.I.C. Pp. ix + 184, 8vo, 9¾ × 7½. (London: Benn Brothers, Limited, 1922.) Price 25*s*.

MECHANICAL TESTING. By R. G. Batson, M.Inst.C.E. M.I.Mech.E., and J. H. Hyde, A.M.Inst.C.E., M.I.A.E., A.M.I.Mech.E. Vol. II. Testing of Prime Movers, Machines, Structures and Engineering Apparatus. (The Directly Useful [D.U.] Technical Series.) Pp. xi + 446, 8vo, 8½ × 5½. (London: Chapman & Hall, Ltd., 1922.) Price 25*s*.

PHILIPS' NEW COMMERCIAL MAP OF CHINA. Edited by Sir Alexander Hosie, M.A., LL.D., F.R.G.S. Size: 62 × 45 inches. Scale: 48 miles to 1 inch. (London: George Philip & Son, Ltd., 1922.) Price, mounted on cloth and varnished, with rollers, 50*s*. Mounted on cloth, folded in French case, 55*s*.

SHIPS OF THE ROYAL NAVY. By Oscar Parkes, O.B.E., M.B., Ch.B. Pp. 189, 8vo, 7¾ × 5. (London: Sampson Low, Marston & Co., Ltd., 1922.) Price 6*s*.

VOL. XX, 1922

INDEX

Botanical names and titles of books are printed in italics and authors' names in capitals